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ELECTRICITY AS A MEANS TO AN END.

Electricity occupies a peculiar position in our every-day life. From the frequent use of the word one would think that it is one of those things most essential for our happiness. This is true in a way, but how many stop to think that actually they never use electricity at all; they only use the effects which it produces. Our electric lamps give us light only because a little thread of carbon or a short column of gas is kept incandescent by heat. Our electric cars are for moving us about, not for transporting electricity. We get from the telephone and telegraph noises, and not electric currents. Electricity, then, is merely an agent by which these other actions are produced, but, happily for us, it is the most convenient and the most universally applicable agent which we have ever discovered. Exception to the general statement made above may properly be taken with respect to the use of electricity in therapeutics, an important application, but one which, for the moment, we have not in mind.

One interesting result of the peculiar position occupied by electricity is the relation of the electrical manufacturers and supply companies to the public. Who of us ever buys an incandescent lamp or a telephone? These are all bought from the makers by large companies who supply us not merely with lamps, but with light or with telephonic communication. As regards the telegraph, the same is true, and so it is with respect to the railway motor. These are all bought by large companies which have more or less of the character of public service corporations.

An exception may be made with respect to the constant-speed motor, whether for alternating or direct current. But then again, these are generally used in factories, and not by the general public. Indeed, it is somewhat remarkable that, although electricity itself does so much for us, individually we have practically nothing to do with it. There is one main reason for this. It is because electrical energy is better for transmitting power from one point to another than any other form of energy. This is true of the telephone, for the work performed by a small vibrating sheet of iron causes a similar sheet to vibrate in unison somewhere else. It is true of the electric lamp, for the heat which produces the light is generated by electricity, itself generated at a distant station. The convenience of the electric motor depends upon the same effect. The coal burned a mile or more away enables us to operate our machinery when and how we please, without our knowing where or how the coal is burned or the water power is employed. Electricity is, then, as was said above, merely a means to an end, but a most convenient means to almost any end.

STATION SIMPLIFICATION.

One of the marked tendencies of modern central-station design is toward general simplification of the entire plant. This tendency is due not only to a desire to reduce the cost of the station, but because it is believed that the simpler the plant the more reliable it is, and, at the same time, the less the upkeep. It is true that this simplification sometimes means abandoning certain practices which were introduced with a view toward adding reliability to the plant, but larger experience in the design and operation of electrical machinery has brought greater confidence in the machines themselves, and to-day less need is felt for providing for every thinkable contingency. Moreover, the increased size of the central station and of the generators themselves has made it possible to adopt different methods of treating trouble. In an electric generating station of ten or twelve years ago, trouble on the line caused either a disaster at the station or a disconnection of the line. To-day a short-circuit on the line brings but little risk to the generating station, since

the power which may flow through the fault represents a smaller part of the total output of the station than was true in the earlier plants. Frequently, trouble of this kind may be allowed to burn itself out. or is taken care of by an automatic switch. This switch, however, is designed so as not to be opened as soon as the fault occurs, but only after it has persisted for a time.

It is interesting to follow the changes in the layout of a central electric station. The old ideal used to be an arrangement which enabled any generator to be operated from any engine. This was accomplished by the use of line shafts, to which any or all of the engines might be belted at will. In those days everything was coupled together except alternators, for the boilers were fed into a common header, and the engines were belted to the same line shaft, to which all the generators were also belted, and in direct-current stations it was the custom to operate the generators in parallel. For alternating-current stations, however, although it had been shown theoretically that it was possible to operate the generators in parallel, the practical man hesitated for some years, and though his switchboard frequently provided for this method of running, he never availed himself of it.

The first departure from the old ideal occurred at the engine, when the line shaft was eliminated. Then it became impractical to operate more than two or three generators from the same engine without adopting an arrangement of engines which was anything but satisfactory, though it was thought desirable that one generator should not be dependent upon a single engine. When the direct-connected generators came into use, this made still more difficult the operation of one generator by any one of several engines, but a very ingenious system was devised by Mr. B. J. Arnold, which accomplished the end nicely, and bridged over the change from multiple driving to individual driving. The ideal arrangement at this stage was everything in straight lines; the boilers in one, the engines and generators in a second and the switchboards in a third.

Up to this point we have the boilers connected in parallel as well as the generators with engines operating independently. The last step has been the separation of the boilers, or, rather, the grouping of boilers in independent sets. This has been brought about for several reasons, one of them being the comparatively small floor space required by the steam turbine, which makes desirable a new arrangement of boilers, and suggested their separation into independent groups.

This arrangement leaves only the generators in parallel at the bus-bars, and it is somewhat interesting to note that, as the alternating-current system has become standard for large stations, practice to-day consists in doing exactly what was not done ten years ago—that is to say, we operate our boilers and engines independently, but parallel our alternators, while in those days we paralleled everything but the alternators.

This separation of the power-station apparatus into independent groups has some advantages. That which will appeal most to the operating engineer is simplification. It is true it has some drawbacks, since it involves banking a set of boilers whenever a generating set is shut down, but as stations are operated to-day this is not of such great importance.

POWER FROM NIAGARA FALLS.

Some alarm has been expressed recently lest the large power plants now being erected at Niagara Falls may produce a noticeable effect upon that magnificent waterfall. Fear seems to be felt that the work will not stop when the plants now in course of erection are completed, but that the present companies will enlarge their works or that other companies will be formed which will eventually draw off most of the water which now goes over the falls, leaving nothing but a rocky bed down which will trickle an insignificant little stream. To prevent any such happening, it is urged that the state or the federal government shall take some action which will guarantee the preservation of the falls.

This alarm seems to be largely unnecessary, as a little consideration of the present conditions will show. When all of the plants now in course of erection at the falls have been completed, and the last turbine installed, the total output will be something less than 600,000 horse-power. The total power of the falls has been variously estimated at from five to seven million horse-power, so that the present undertakings will, at the most, draw off only about one-tenth of the water flowing down the Niagara river. Looked at in this way, the output of the plants is small, although, when compared with the total hydroelectric developments of the world, it is very considerable. Now, this figure of 600,000 horse-power—it is a little more than this if one adds in the plants along the Welland canal—is what is suggested for the future, and not what will be the immediate output of the plants when they are first put into service. Mr. C. B. Smith, who was until recently prominently engaged in the construction work at Niagara Falls, says that, for a generation at least, not more than 400,000 horse-power will be consumed in the Niagara region. This figure probably represents the maximum output of the Niagara plants for some time to come. The machinery for developing the additional 200,000 horse-power which the charters of the present companies allow them to produce will not be installed until the companies are assured that they can dispose of it. To do this, the power must be transmitted some distance, but this is expensive and can only be done when it would be more expensive to use coal.

It has been shown that, while the development of our waterfalls is important, this work will have little, if any, effect upon the consumption of coal, and hence will not tend in any way to reduce the price of this fuel. On the other hand, every increase in the price of coal enhances the value of the waterfalls. Our coal supplies will last for a long time to come, so that danger of exhaustion can not be urged as an excuse for the installation of additional plants at Niagara Falls. It must, however, be borne in mind that every pound of coal burned represents the deduction of just that much from the resources of the country, while the use of a waterfall is simply converting to useful purposes energy which is otherwise going to waste. When we can see the end of our coal supplies we will be ready to look at the situation in a different light, and then it will be recognized that, although the Niagara falls have a great value as a spectacle, they will then be far more valuable as a source of power. By

that time we shall probably have devised more economical methods of using our fuel, and we will, at the same time, have so organized our forestry works as to ensure a continued flow of water through the Niagara river, provided, of course, the lakes do not find a new outlet at Chicago, as has been threatened. Let us hope so, at least.

TRANSMISSION OUTLOOK.

The noteworthy achievements of the last ten years in long-distance transmission of electrical energy have led many to believe that almost anything is possible in this field; and being possible, it will be profitable. The conclusion is far from being justified. The transmission engineer would have some difficulty in setting limits to the possible, but he would have no difficulty in drawing a line to mark a region beyond which transmission certainly would not be profitable under present conditions. Within this line would be, first, a region of debatable ground which would require careful study to determine what parts of it should be developed. Still nearer to the source of power would lie the section offering profitable development, if any such section exist, a question which also must be determined by careful study.

Should it be found to pay to transmit to a certain distance, it does not necessarily follow that it would pay as well, or even pay at all, to transmit to all points within that distance of the source of power. A factory immediately at the power plant may find it can produce its own power at less expense than it can buy it from the larger station. The cost of transporting or transmitting energy either in the form of fuel, water or electricity does not necessarily vary directly as the distance it is carried.

It is true of a transmission project, as of any other undertaking, that the decision must rest on its money-making probabilities, and not on its merits as a beautiful piece of engineering. In a lecture delivered recently by Dr. F. A. C. Perrine before the Brooklyn Polytechnic Institute some of these phases of transmission problems and the conditions influencing them were discussed. These conditions may be natural, or they may be wholly artificial, but in any case they must be reckoned with. One interesting case coming in the latter classification is that of a mine owner who is entirely surrounded by a competitor and who can dispose of his product only to this rival. He may, as suggested, find a profitable outlet by erecting a generating station and selling, not his coal, but the electrical energy which he produces by means of his coal, at distant points.

Another instance when electrical transmission may be found to pay is when fuel in a certain locality is exceptionally dear because of lack of railroad facilities. Doubtless many sections will be found where electrical transmission may be undertaken because of some such local conditions and it is in this direction that Dr. Perrine expects the greatest development of electrical transmission to take place. The work will probably be done quietly and will attract little attention because it will lack those features which appeal most to the public, stupendous size, as at Niagara Falls, or enormous distance, as in California.

SWITCHBOARD SIMPLIFICATION.

The process of station simplification has, unfortunately, not extended to the switchboard, or, rather, to what is to-day virtually a switch-house. Here the apparatus has not only increased in size and in complexity, but the number of appliances deemed necessary has been multiplied. As voltages have increased, the difficulties of installing safely these high-potential devices has also increased. The increased voltage has itself increased the number of appliances needed, for now every station instrument must have its transformer, and these must be properly housed, since they are connected to the high-voltage system. The increase in voltage, as well as in the output of the stations, has made necessary a great change in the design of switches. Where formerly a double-pole, double-throw knife switch answered all needs, there must to-day be groups of high-potential, mechanically operated oil switches, which are not only more or less complicated in themselves, but which make necessary a secondary operating switchboard, with its sets of switches and indicators. Further, the operator at the switchboard has extended his control until he can now change the speed of the driving engines; and in order that he may conduct his work confidently, automatic signaling systems are installed. This increase in complexity of the switching—or possibly one might better say the distributing—appliances is undesirable, but it is hard to see where it could be simplified. A large station should have at least two sets of buses, and this being the case, the necessary switches for connecting any generator to either set must be installed. It has become the custom to place indicating and recording instruments wherever they can be of any service, and the few protecting devices which are installed are necessary as safeguards in times of unusual difficulties.

Comparing the switching devices of a large high-tension, alternating-current station with generators operating in parallel, with such a system as has been introduced by Thury, where several moderately high-potential, direct-current generators are operated in series to give a much higher voltage, which is used for distribution, the difference is striking, as practically all the switching appliances of the parallel plant are done away with. All that is needed is one simple switch, which cuts in or cuts out each generator. The Thury system is very pretty in a way, and other advantages besides simplification are claimed for it. It is even hinted that it will be practicable to operate such a system at 100,000 volts; but, somehow or other, it does not seem suitable for general purposes. It may be well enough for generating power at one point and distributing it at another some distance away, but for general distribution it has not the flexibility of the constant-potential system. It suggests, however, the desirability of simplifying the switchboard of the modern high-tension station, if it can be done. In almost every other part of the station this is the direction in which we are working, and, indeed, this same principle is being followed—as far as may be—in other electrical applications. As was said above, it is not easy to see just where simplification can be made, but it is worth while calling attention to its desirability.

SOME TESTS ON THE USE OF THE SYNCHRONOUS MOTOR IN COMPENSATING FOR LAGGING CURRENTS IN A CIRCUIT.

BY E. A. REGESTEIN.

The use of the synchronous motor to regulate the power-factor of a transmission line or distributing circuit has of late received considerable discussion. Some tests made by the writer serve to bring out this property of the synchronous motor very clearly.

To begin with, a few words as to the considerations involved may not be out of place. As is well known, if the excitation of a synchronous motor running at constant load from constant potential mains be varied, the current taken by its armature, and therefore its power-factor, vary correspondingly. For a stable condition of operation the counter-electromotive force induced in the armature of

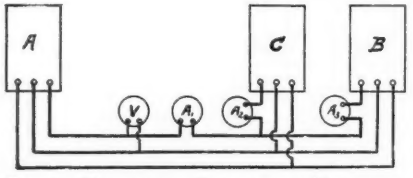


FIG. 1.—METHOD OF CONNECTING MACHINES.

the motor must equal the impressed electromotive force minus the impedance drop through the armature due to the current flowing. If, now, the field current of the motor be varied, since the speed can not change, and the counter-electromotive force must remain the same, a wattless magnetizing current will be taken from the line by the armature, which reacts on the field, so as to keep the flux at the required value independent of the field current. Hence, as the field current is diminished a wattless magnetizing current, lagging with respect to the impressed electromotive force, will be taken from the line, in addition to the current in phase with the impressed electromotive force which supplies the power required. This current strengthens the field flux, raising it above the value due to the field current alone. The smaller the field current the greater will be the wattless magnetizing current flowing in the armature to keep the flux at the required value. Similarly, if the field current is increased beyond the value which gives the required flux, a wattless magnetizing current leading with respect to the impressed electromotive force will flow in the armature, counteracting the excessive ampere-turns on the field. Thus, as we increase the excitation from a low value the power-factor of the motor increases until at normal excitation we have unity power-factor. As the field current is still further increased the power-factor again diminishes due to the leading current taken by the armature.

Under ordinary conditions the field current is adjusted so that the armature current is a minimum, *i. e.*, the motor is running at unity power-factor. Where, however, the motor is connected to a transmission line or distributing circuit of which the power-factor is less than unity due to lagging current, by overexciting the motor, causing it to take leading current, we may bring up the power-factor of the line. If the motor is of sufficient capacity the leading current of the motor may fully compensate for the lagging current on the line giving unity power-factor on the generators. In other words, the line is now drawing its wattless current from the synchronous motor instead of from the generator.

In this way the resultant current in the line is reduced. This mere fact will also reduce the line drop. If the line has appreciable inductance, moreover, the drop is still further reduced by bringing the current and electromotive force into phase. By overexciting the motor sufficiently we can actually raise the voltage of the line.

Since overexcited synchronous motors connected in this way take leading currents, they are frequently called rotary condensers. Rotary condensers have been installed in a number of instances on a system feeding induction motors. Due to the compensation of the lagging currents

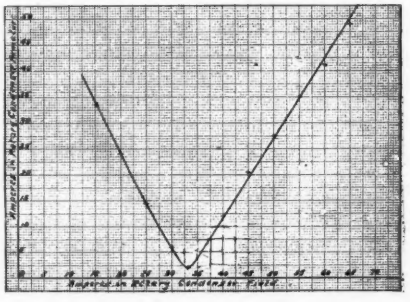


FIG. 2.—RELATION BETWEEN AMPERES IN FIELD AND ARMATURE OF ROTARY CONDENSER.

taken by the induction motors, by the leading current taken by the rotary condenser, the generators being relieved of this wattless component have been enabled to carry a much greater connected load.

The following test brings out these points very clearly. Three machines connected as in Fig. 1 were used. A, the generator was a 500-kilowatt, three-phase, 2,200-volt machine; B was a 700-horsepower, 2,200-volt, induction motor; C was a 150-kilowatt, 2,200-volt, synchronous motor. The induction motor was run free, taking from the line a large current which lagged nearly ninety degrees behind the electromotive force. Readings were taken of the volts between mains, the amperes taken by the synchronous motor, the amperes taken by the induction motor,

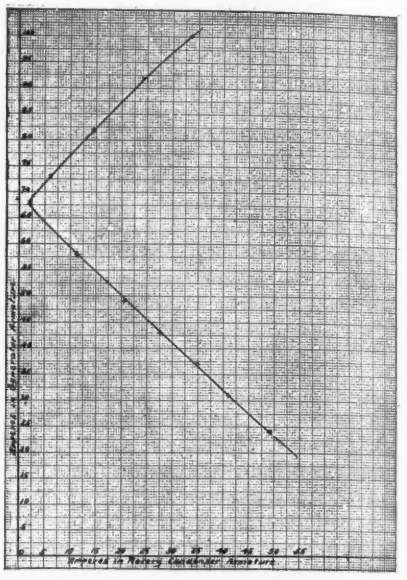


FIG. 3.—RELATION BETWEEN AMPERES IN LINE AND IN ARMATURE OF ROTARY CONDENSER.

and the amperes delivered by the alternator. At the beginning of the test the field current of the rotary condenser was such as to cause it to run at unity power-factor, taking a small current sufficient to overcome its losses while running free. Two series of observations were taken, the first for increasing values of the field current in the rotary condenser and the second with decreasing field currents. The voltage between the mains was maintained constant throughout the test at 2,200 volts by varying the field excitation of the generator.

The readings are shown in tabular form:

Line.	Alternator.		Rotary Condenser.		Induction Motor.
Volts.	Armature Amperes.	Field Amperes.	Armature Amperes.	Field Amperes.	Amperes.
2200	68	50.0	2.0	33	68
2200	58	47.5	11 8	40	68
2200	49	46.0	20.5	45	68
2200	43	44.0	27.5	50	68
2200	37	42.5	35.0	55	68
2200	31	42 0	41.0	60	68
2200	24	40.0	49.0	65	68
2200	68	50 0	2.0	33.0	68
2200	73	51.0	6.0	30.0	68
2.00	82	55.0	14 5	25.0	68
2200	92	56.5	24.0	20.0	68
2200	100	58.8	33.5	15.5	68

The induction motor, being connected

to constant potential mains at no load, takes a constant current. The field current of the generator, it will be seen, was decreased in order to keep the voltage constant in the first series, and increased in the second series. The amperes delivered by the generator decrease in the first series and increase in the second. The amperes taken by the rotary condenser armature increase in both series.

The increase of the current in the rotary condenser armature both for an increase and for a decrease of its field current is in accordance with the considerations above, the current being leading for larger field currents and lagging for the lower field currents. Fig. 2 shows the relation between amperes field and amperes armature of the rotary condenser, being merely its phase characteristic.

Fig. 3 shows the relation between amperes in the line and amperes in the armature of the rotary condenser. The curve changes direction abruptly at the armature current in the rotary condenser corresponding to normal excitation, *i. e.*, at unity power-factor on the rotary condenser. As this current increases due to overexcitation, the current being leading, the line current falls off. On the other hand, as the rotary condenser current increases due to underexcitation, it being lagging, the line current also increases. The line current is the vector sum of the current taken by the induction motor and the current taken by the rotary condenser. As the field excitation of the latter increases, the leading current drawn

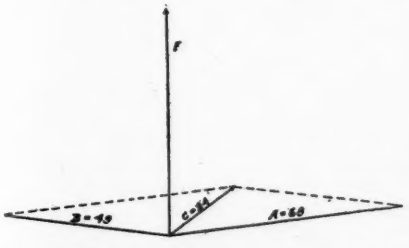


FIG. 4.—RELATION BETWEEN CURRENTS.

by it from the line counterbalances the lagging current in the induction motor, causing the line current to decrease. Fig. 4 shows the vector diagram of these currents for the readings corresponding to a field current of sixty-five amperes in the rotary condenser; A representing the lagging current taken by the motor, B the leading current taken by the rotary condenser, C the resultant line current delivered by the generator, and E representing the phase of the electromotive force; E not being drawn to scale on account of its extreme length compared to the current vectors. The tests were carried as far as the current capacity of the rotary condenser would permit. By increasing the field of this machine still further, the resulting greater armature current would, as indicated in Fig. 2, still further reduce the line current. This would continue until the leading current in the rotary condenser exactly balances the wattless current in the line, and the current and

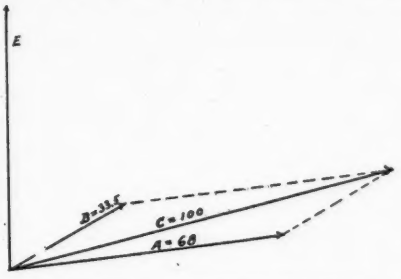


FIG. 5.—RELATION BETWEEN CURRENTS.

electromotive force in the line are in phase. If a still further increase in the rotary condenser current be made, the current delivered by the generator will again increase, it leading the electromotive force.

Fig. 5 shows the relation of the currents for the upper part of the curve; Fig. 2, when the rotary condenser takes lagging current due to underexcitation.

As in Fig. 4, A represents motor current, B the current taken by the rotary condenser, C the resultant line current and E the phase of the electromotive force. The diagram is drawn to show the relation existing for the set of readings taken with 15.5 amperes in the field of the rotary condenser. As the line current is much greater under these circumstances, the use of an underexcited synchronous motor should be avoided.

It is to be noted that although the machine used as a rotary condenser was run unloaded, there is no objection to taking a useful load from the machine provided that the machine is of sufficient current capacity. This will merely cause the machine to take an additional current from the line in phase with the electromotive force supplied. Since this current is in quadrature with the magnetizing current, the actual current flowing will be less than the numerical sum of these two components. We could utilize a given machine to the greatest extent by loading it up equally with a useful and with a wattless component of current. Under these conditions each component may reach 0.71 of the normal current capacity without having the resultant current exceed that capacity. Where, however, the total capacity is required for wattless leading current to balance lagging current on the line, a useful load could not be taken without overloading the machine. The permissible useful load would depend, in a given case, entirely on what fraction of the total capacity was being taken up with wattless current. In several instances machines have been designed with a view simply to relieve the generators of the wattless component of the inductive load, leaving, therefore, no capacity for useful load.

It should be borne in mind that in ordinary working the possible reduction in generator current would not be as great as in this particular test, since in this case the load current was almost entirely inductive. The wattless component alone can be reduced. The possible reduction in current in a given plant would, therefore, depend entirely on the power-factor at which the plant in question is operating.

In this test no attempt was made to determine the possible variation of the line voltage by regulating the field of the rotary condenser. The voltage was kept constant by regulating the generator field. The tendency of the rotary condenser to raise the voltage is very evident, however, since the greater the field current in the rotary condenser the further must the generator-field current be reduced to keep the line voltage constant. The degree of this voltage regulation would depend, of course, on the inductance of the circuit. Fig. 6 shows the relation between field

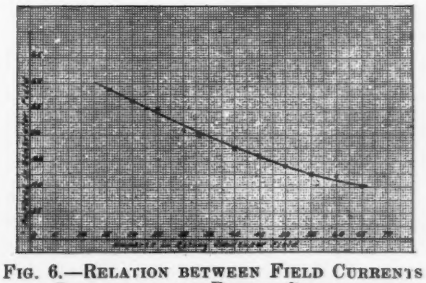


FIG. 6.—RELATION BETWEEN FIELD CURRENTS OF GENERATORS AND ROTARY CONDENSERS.

currents of generators and rotary condenser to maintain constant line voltage.

As an example of what may be accomplished in an actual installation may be cited the case of a certain cotton factory in the South, which was equipped with about 4,000 horse-power of induction motors and 3,000 horse-power of generator capacity. Due to the fact that the average load on the motors was low the power-factor was likewise low, requiring excessive current and voltage at the generators. Instead of installing additional generator capacity to handle the required current, a 500-kilovolt-ampere rotary condenser was

installed to supply the lagging currents, thereby relieving the generators. By this means the current delivered by the generators was reduced about twenty per cent, while the voltage required at the generators was reduced about fifteen per cent. The rotary condenser was much cheaper than another generator installed in the power-house together with its engines. Also since the rotary condenser can be installed at the centre of distribution, the line from the power-house is likewise relieved of the same amount of current, and its regulation correspondingly improved.

Meeting of the American Trade Press Association.

At the regular meeting of the American Trade Press Association held at the Hardware Club, New York, Friday evening of last week, Mr. Arthur Warren, manager of publicity for the Allis-Chalmers Company, Milwaukee, Wis., delivered an address on technical and trade journals from the standpoint of the advertiser. There was an excellent attendance, and the speaker's interesting and instructive address was listened to with close attention and much applauded. The address was discussed at some length by members of the association.

Mr. Warren presented in a particularly felicitous manner the questions of character of publication, the field it directly reached, its circulation and its editorial and news scope as valuable elements entering into the manufacturer's decision of a journal's advertising value, and permitted a vein of subtle sarcasm in dealing with the circulation question with some of the methods that had obtained in the past in the efforts made to secure advertising, such as the "meaningless write-up" and the influencing of orders through the personality of the publisher. The question of circulation was discussed at some length and the belief expressed that honest, reliable figures were to be desired as against unverified claims, and the figures given in Rowell's (American Newspaper Directory) were used as a basis of comparison. Mr. Warren concluded as follows:

But there is one nuisance that we all know about, and that is the "write-up." It is a nuisance to you; it is a nuisance to us.

But there is a vast difference between the "write-up," dreary, fruitless, and undisguised, and the timely article that has news value, or interest for the commercial or industrial world, for the factory, the mill, the executive, the artisan, the engineer, the miner, the financier, or the operative. These articles are legitimate, if they are well written and informing. A good deal depends on that. The custom has grown up for the manufacturers to supply articles to the trade and technical press. If these articles are not always well written it is because of the difficulty we all experience, manufacturers as well as editors and publishers, in finding the men who can write well. On the other hand, if editors complain because they do not receive articles of sufficient merit, the owners of the papers must in some part blame themselves. The trade and technical press has added a new problem to the many problems of the manufacturer. I would hesitate to tell you how many requests a great engineering concern receives for articles to be written by its engineers who are experts in their respective specialties. You might think the mere figures an exaggeration. But the fact is that if all these requests were complied with the engineers would have little time left for engineering. And, after all, designing, and constructing, and installing, to say nothing of selling, are what their employers pay them for. If the requests of the press are to be complied with the manufacturers must employ a staff of writing engineers. This, however, would seem to be the proper function of the press itself.

Some papers are very conservative in these matters, carrying conservatism to the point of superstition. They are quite within their rights, and they know best whether they gain in the long run; whether they give their readers precisely what their readers want. The other day the editor of a prominent trade journal returned a short biographical sketch and portrait of a well-known engineer who had just abandoned an old faith for a new one, going up higher among the mighty of a competing concern, and he said—the editor—"we do not publish biographies, and never print portraits. In thirty years" (or it may have been twenty) "we have had but one biographical account in our columns, and that was an obituary"!

Yet in thirty years, or even in twenty, there have been engineers worth mentioning. And some fond foolish persons, like ourselves, have a sort of sympathy with papers that deal with living men rather than with dead ones. (Applause.) And it may be noticed that for business reasons, and for professional reasons, business men and professional men turn more and more to the papers that combine dignity with enterprise.

There is a field of enterprise which the trade and technical press has yet to develop. You cover the advertising field very thoroughly, most assiduously, with a persistence which even the Japanese army and the heroic defenders of Port Arthur might envy. But you have not yet developed the field of information. A hundred, two hundred, advertising solicitors visit the manufacturer; editors very rarely appear. Send out your writers to the manufacturers, not merely your advertising solicitors; borrow a leaf from your colleagues of the magazines and the daily press of the better sort. It will pay you. And it will pay best the papers who send the best men and who send them most frequently.

There should be, and there can be, closer touch between the papers and the manufacturers. And that closer touch can be obtained without the loss of any independence on the part of the press. The papers that are not independent, the papers that are partisan and that curry favor, are the papers we don't want. The manufacturing concerns are sources of news. You want technical news, and perhaps other kinds of news. But very often, especially in regard to large undertakings, you do not get the information until it has lost its news value. There are reasons for that. Perhaps they will never be entirely overcome, because the manufacturer has not only to guard his own interests, but he has to guard the interest of his customer. When large investments are at stake the persons who are paying the money have the privilege of keeping their own counsel. You, as business men, can understand that clearly enough. And again, when the manufacturer is producing a new invention he prefers silence until he has protected himself by patents, completed his tests, and perhaps made a successful installation or two.

But it is not impossible that a place may be found whereon the manufacturer and the press can meet to their common benefit, where you can obtain information while it still has the quality of news, and news backed with authority. And to find this meeting place there is no better way than to send out your best writers on exploring expeditions. Cultivate personal relations between the men who have the information to impart, and the men who know how to put it together in an interesting and useful manner. Your writers will learn something new wherever they go, if they are the right men, and if they go about it in the right way. I, for one, shall have no sign at my door forbidding them entrance. There are writers on your staffs whom the ablest men in the engineering world will be glad to meet, to whom courtesies and facilities will be extended, and who will themselves be benefited, and through them their papers, by personal contact with the actual conditions that prevail. If you have not writers enough to spare from your offices you can get them.

I can see the twinkle in your eyes; I can anticipate exactly your immediate response: "Enlarge our advertising contracts so that we can afford to do this thing!" But if a man can not dine on bread alone (and the evidence to-night is that he does not if he is a publisher), neither can the press live on advertising alone. You are doing good work now. Do more of it. There are new activities in which you can engage. If you are liberal be more liberal still. And if I am not mistaken you can do much to bring about a condition of affairs in which you will not be perpetually chasing the advertiser, but the advertiser will be running after you.

The Power Plant of the Chattanooga Electric Company, Chattanooga, Tenn.

THE Chattanooga Electric Company, of Chattanooga, Tenn., completed an important addition to its plant in July of last year, which, on account of the installation of Curtis steam turbines and the introduction of some novel features, will be of interest to describe.

The addition to the plant consisted of a seventy-five-foot extension to the old building, on the same general lines, only that the new part has a steel truss roof covered with book tile and asphalt, and the floors are of iron girders filled in with corrugated iron arches and concrete, overlaid with red and white hexagon tile. The present building with the extension is of red brick, 180 feet long and 82 feet 2⅝ inches wide.

The engine room is 45 feet 10 inches wide and 165 feet long.

The boiler room is 36 feet 4⅝ inches wide and 180 feet long.

The floor of the boiler room is three feet below the floor of the engine room.

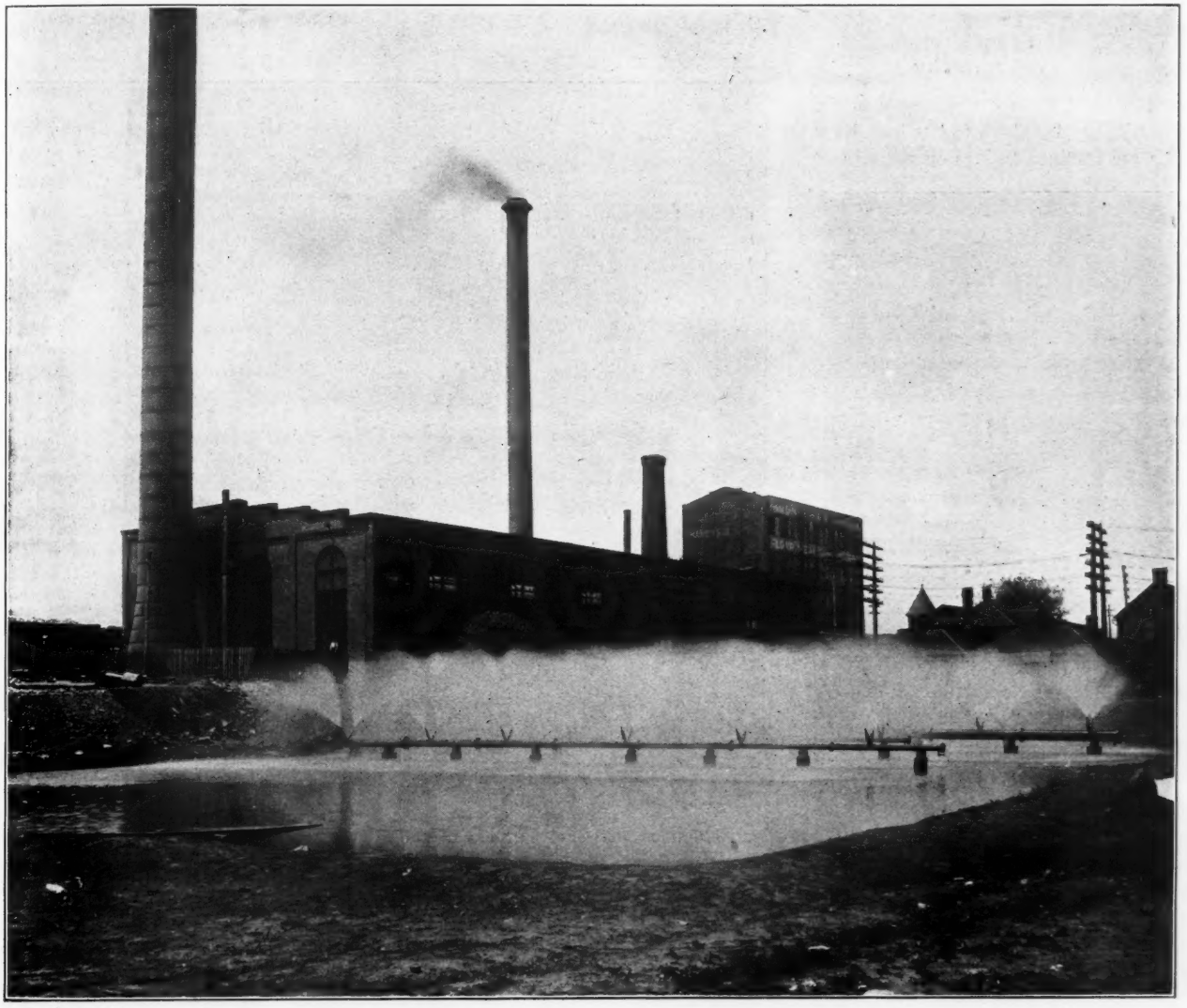
The height of the engine room to the bottom of the roof trusses is 27 feet 6 inches.

The engine room is provided with a ten-ton traveling crane having a span of 44 feet 7 inches.

Light is admitted through twelve arched windows on the north side of the building, each of which is ten feet wide and reaches to the roof.

The steam-raising equipment, which remains of the old plant, consists of four 250-horse-power water-tube boilers of the Babcock & Wilcox type, and one 800-horse-power Goubert feed-water heater and Worthington duplex feed-water pumps.

The four boilers are connected to a self-supporting steel stack 150 feet high and 6 feet inside diameter, which is lined with firebrick part of the way, the balance being of common brick.



THE POWER PLANT OF THE CHATTANOOGA ELECTRIC COMPANY, CHATTANOOGA, TENN., SHOWING COOLING POND AND SPRAY.

In the old engine room there has been retained one Harrisburg standard, tandem-compound, 400-horse-power, non-condensing engine, direct-connected to a 200-kilowatt, three-phase, 2,300-volt, General Electric alternator, and a 225-kilowatt, 500-volt, direct-current, General Electric generator.

In the new addition have been installed two batteries of Babcock & Wilcox water-

tube boilers, each battery containing two 410-horse-power boilers, having 4,046 square feet of heating surface and 67.6 square feet of grate area each. These boilers have the new extension or Dutch oven furnaces which extend four feet from the boiler fronts.

The boilers connect to a new self-supporting steel stack 200 feet high and 10 feet in diameter inside of the firebrick lining, which extends from bottom to top. The main flue at its largest part is 7 feet wide and 10 feet 6 inches high. The main damper is operated by a Locke damper regulator.

The foundation of the stack contains nearly 25,000 cubic feet of broken stone concrete, and the stack is anchored to the foundation by twenty-four two-inch bolts which are fastened to lugs on the side of

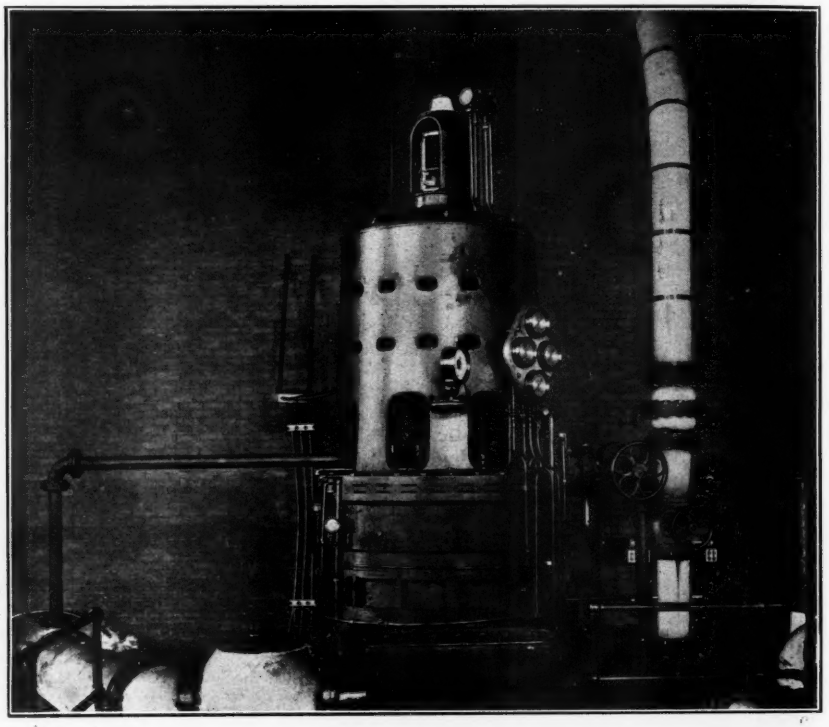
THE PIPE LINE AND NOZZLES IN THE COOLING POND.

the stack. A good close view of top of the stack assembled before putting up is shown on page 322. The stack was designed by Sargent & Lundy, consulting engineers, Chicago, Ill., and was built by Walsh & Weidner, of Chattanooga, Tenn.

Coal is brought in over a trestle and dumped into bins at the rear of the boiler room, from whence it is wheeled in over three dormant floor scales and registered by counters similar to fare registers. In this manner an accurate account of fuel and output is kept for each twelve-hour run.

In the extension to the engine room there have been installed three General Electric-Curtis steam turbines and alternators of 500-kilowatt capacity each, and a foundation for a fourth turbine has been provided. These alternators are three-phase, sixty-cycle, 2,300-volt and run at 1,800 revolutions per minute.

Oil is forced into the step bearings of the Curtis turbines at a pressure of 250 pounds per square inch by means of geared plunger pumps driven by direct-current motors, and as a provision against failure of this source of oil supply a Worthington duplex steam plunger pump is arranged to start up automatically in case of failure of one of the electric pumps. Even if the steam pump should fail to start promptly the flow of oil and pressure would be maintained for thirty minutes by means of an accumulator which works on the principle of a hydrostatic press. In practice all of this oiling arrangement is extremely practical and satisfactory.



CURTIS TURBO-GENERATOR OUTFIT.

A new type of mercury vacuum gauge indicates the vacuum in each turbine and condenser. These gauges are short glass tubes closed at the top in the same manner as a barometer, with the bottoms dipping into a mercury well hermetically sealed from the atmosphere but connected to the condenser. An absolute vacuum in the condenser would cause the mercury in the column and that in the well to come to the same level, the difference in level being a measure of the vacuum in inches upon the scale. These gauges have exhibited many advantages over the old style of open gauges.

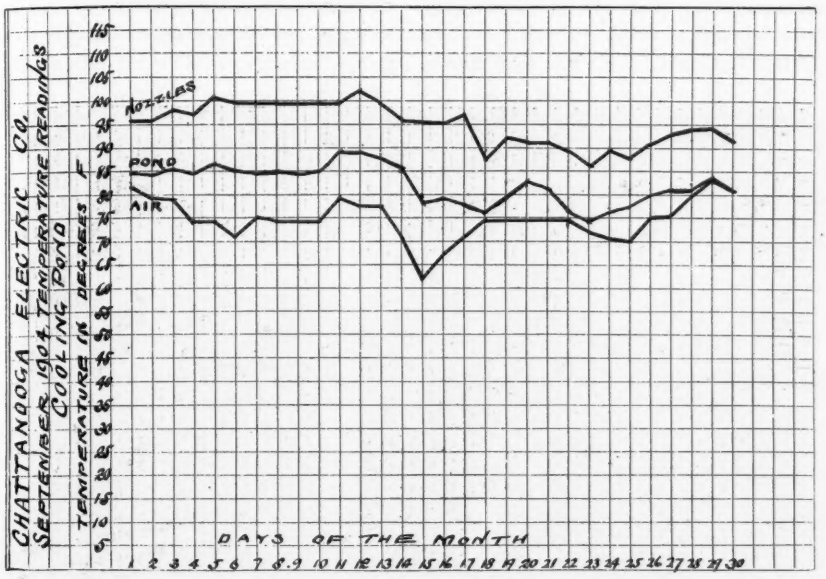
Each turbine exhausts into a Worthington surface condenser having 2,000 square feet of cooling surface, and the water from the hot wells is pumped back to the feed-water tanks by Worthington two-stage centrifugal pumps, driven by General Electric three-horse-power, three-phase motors running at 1,800 revolutions per minute.

The condensing outfit also consists of two Worthington 8 by 14 by 10-inch horizontal rotative vacuum pumps; one Worthington seventy-five-horse-power centrifugal pump, driven by a seventy-five-horse-power General Electric, three-phase, 2,300-volt motor; one two-stage, seventy-five-horse-power Worthington centrifugal pump, driven by a New York Safety Steam Engine Company's vertical steam engine, the exhaust of which is used for heating the feed water.

The plant being located some distance from the river it was not possible to utilize the river for condensing purposes, and it was necessary to resort to other methods for obtaining condensing water. The plan adopted of spraying the water into the air by spray nozzles has proved very satisfactory.

This part of the equipment consists of forty-two spray nozzles furnished by the Schutte & Korting Company, Philadelphia, Pa. These nozzles are provided with a conical-shaped core, having spiral grooves which give the water a rotary motion and form a spray fountain about

twenty feet high and thirty feet in diameter. The water is conducted to the nozzles through a system of piping supported upon brick piers in the pond and is returned to the condenser through a



RELATION OF NOZZLE TEMPERATURE TO AIR AND COOLING POND, SEPTEMBER, 1904.

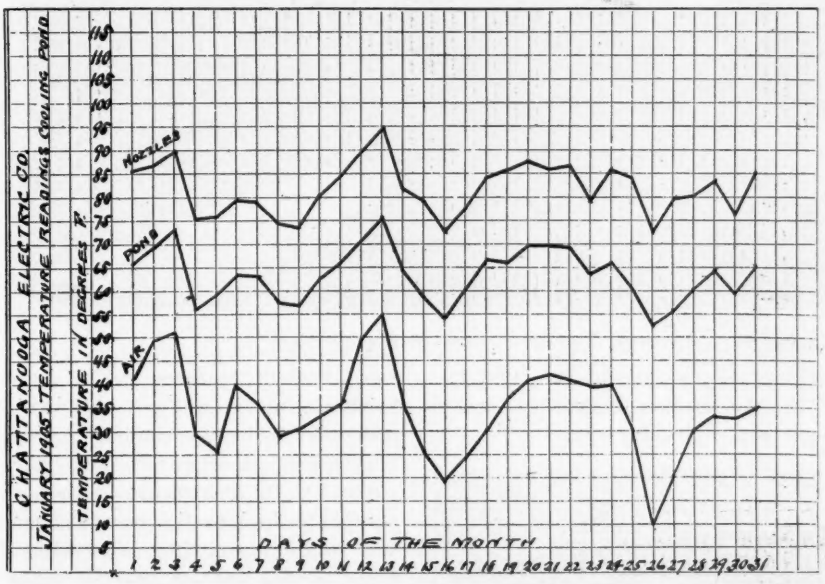
twenty-four-inch pipe by means of centrifugal pumps.

The spray fountains, of course, work better during cold weather than they do during warm weather. This will be seen from the daily temperature readings for the months of September, 1904, and January, 1905, the average number of degrees cooling in September having been 12.10, while in January it was 18.25, but the cooling has been sufficient to maintain a vacuum varying from twenty-seven and one-half to twenty-eight inches. The accompanying plotted temperature shows the striking sudden variations of temperature in Chattanooga in January and how closely the temperature variations of the pond water follow those of the atmosphere.

The pressure at the nozzles is fifteen pounds per square inch. The loss of water due to evaporation and seepage into the earth is made up from a driven well 500 feet deep, from which water is obtained by means of an air-compressor built by the Ingersoll-Sergeant Drill Company.

The new boilers are supplied with feed water through either of two pumps, one of which is a 9 by 6 by 10-inch vertical Worthington duplex Admiralty pump, mounted directly on the side of a 3,000-horse-power closed coil heater built by the National Heater Company.

The other feed pump is a five-stage



RELATION OF NOZZLE TEMPERATURE TO AIR AND COOLING POND, JANUARY, 1905.

TEMPERATURE READINGS OF COOLING POND IN SEPTEMBER, 1904.

Date.	Temperature Air Dry Bulb.	Temperature Air Wet Bulb.	Temperature at Nozzles.	Temperature Water in Pond.	Degrees Cooled.
1	82	70	96.75	84.87	11.88
2	79	71	95.87	84.50	11.37
3	78	70	97.87	85.37	12.50
4	74	69	97.12	84.25	12.87
5	74	67	102.25	86.50	15.75
6	72	67	99.00	85.00	14.00
7	75	67	99.00	84.75	14.25
8	74	68	99.12	85.00	14.12
9	74	66	99.12	84.37	14.75
10	74	66	99.87	85.00	14.87
11	78	69	99.37	88.87	10.50
12	77	69	102.97	88.87	14.10
13	77	69	99.25	87.75	11.50
14	71	63	96.87	85.62	11.25
15	62	57	90.37	77.87	12.50
16	67	60	90.37	78.62	11.75
17	71	65	92.12	77.37	14.75
18	74	66	87.87	76.37	11.50
19	74	68	92.25	78.25	14.00
20	74	70	96.12	82.50	13.72
21	74	69	91.87	81.37	10.50
22	74	67	89.50	76.12	13.38
23	72	63	86.50	74.62	11.88
24	71	64	89.62	75.75	13.87
25	70	67	87.87	77.12	10.75
26	75	70	91.37	80.00	11.37
27	76	70	93.25	83.25	10.00
28	80	73	94.37	81.37	10.87
29	83	74	94.87	83.50	11.37
30	81	73	92.00	80.62	11.38

TEMPERATURE READINGS OF COOLING POND IN JANUARY, 1905.

Date.	Temperature Air Dry Bulb.	Temperature Air Wet Bulb.	Temperature at Nozzles.	Temperature Water in Pond.	Degrees Cooled.
1	41.12	39.75	85.50	66.62	18.88
2	48.87	47.12	87.00	68.50	18.50
3	50.87	49.87	89.87	73.37	16.50
4	28.00	26.37	75.75	56.50	19.25
5	25.37	24.25	75.25	58.75	16.50
6	39.25	38.25	78.37	63.50	14.87
7	36.12	40.87	77.25	63.00	14.25
8	28.87	27.87	74.87	57.50	17.37
9	30.37	29.12	73.87	56.37	17.50
10	33.25	32.62	81.00	62.50	18.50
11	35.87	34.12	84.00	66.00	18.00
12	49.00	48.50	89.50	70.62	18.83
13	54.62	53.00	94.12	76.00	18.12
14	36.00	34.50	82.12	64.12	18.00
15	26.12	24.62	77.87	58.37	19.50
16	19.00	17.37	73.75	54.37	19.38
17	24.25	22.62	77.87	60.72	17.15
18	30.12	29.75	84.62	66.75	17.87
19	37.00	34.00	85.25	66.25	19.00
20	41.37	40.37	87.50	69.37	18.00
21	42.37	40.62	86.62	69.50	17.12
22	41.75	39.87	86.87	68.75	18.12
23	39.75	37.87	78.12	63.37	14.75
24	40.00	38.12	85.50	66.00	19.50
25	30.50	28.50	84.37	61.62	22.75
26	10.00	7.62	73.50	53.25	20.25
27	20.75	19.12	78.62	56.12	22.50
28	30.00	28.12	80.25	60.75	19.50
29	32.87	30.87	83.37	64.37	19.00
30	32.75	32.50	76.62	59.50	17.12
31	35.00	33.50	85.00	65.87	19.13

Worthington volute pump, direct-connected to a General Electric thirty-horse-power, three-phase, induction motor.

The company furnishes power for operating all of the cars of the Chattanooga Electric Railway Company, and for this purpose has installed four General Electric eight-pole, 300-kilowatt, rotary converters running at 900 revolutions per minute and converting 2,300 volts, sixty-cycle current to direct current at 600 volts for the railway feeders. The rotary converters can be started from either the alternating-current or direct-current end.

For exciting the fields of the alternators there have been installed one vertical marine set, consisting of a compound engine, direct-connected to a General Electric thirty-five-kilowatt generator; one thirty-five-kilowatt exciter driven by a fifty-horse-power, 2,300-volt, three-phase induction motor, and one thirteen-kilowatt exciter driven by a three-phase induction motor.

Four 330-kilowatt General Electric air-cooled transformers are placed directly over a tunnel in the basement, through which air is forced by means of two blowers operated by three-horse-power induction motors. These transformers convert the current from 2,300 volts, three-phase, to 430 volts, six-phase, for the rotary converters.

The switchboard is of black slate and is equipped throughout with the latest type of General Electric switchboard instruments and controlling apparatus.

Cap for New Smokestack.

Single-phase current at 2,300 volts is distributed to the line for lighting purposes through four oil switches. Three-phase current at 2,300 volts is distributed for operating induction motors.

Each of the rotary converters is provided with a Thomson recording watt-meter on the direct-current end for measuring the power sold to the electric railway. Each of the generators has its own polyphase meter, and all the lighting and power feeders are similarly equipped. In addition to these meters each auxiliary motor has its own meter, so that it is possible to check up the amount of power loss in converting from alternating to direct current and the amount of power used for operating the auxiliaries.

The company furnishes all of the street lighting of the city and has recently changed over from the open series arc system to the alternating-current series enclosed constant-current arc system, and supplies current to 230 lights through three 100-light 6.6-ampere constant-cur-

Interior View of Chattanooga Electric Company's Turbo-Generator Plant.

rent General Electric transformers. These lamps took the place of open arcs of 9.6 amperes, and the change is giving great satisfaction to the public.

The Chattanooga Electric Railway Company operates twenty-five cars of seventy-five and ninety-horse-power equipments and weighing from 35,000 to 38,000 pounds each.

The total length of the different lines is about twenty-five miles, most of which is double track and includes several heavy grades. The cars maintain a fifteen-minute schedule and all run into a central transfer station. With this number of cars, equipment and schedule three rotary converters of 300 kilowatts each easily take care of the load, which varies from 500 to 1,500 amperes at 600 volts and an average consumption of 10,000 kilowatt-hours per day of eighteen hours.

The entire plant was built and the machinery manufactured and installed by the General Electric Company.

Since July 4, the date of taking on the entire load of the street railway company and the commercial and public lighting, the turbines have been in continuous and successful operation, without a single breakdown or interruption to the service.

The cost of coal has been cut down to about one-third of what it was when operating with high-speed simple engines, and the cost of feed water has been practically eliminated on account of the possibility of using the same water over again after passing through the turbines. The accompanying photographs are good views of the cooling pond and the interior and exterior of the power-house.

Prevention of Rail Lengthening and Track Spreading.

[*From United States Consul Muench, Plauen, Germany.*]

The spreading and lengthening of rails and track on double-track railways has recently formed an interesting topic of discussion in the engineering circles of Germany. The tendency of steel rails and tracks to lengthen in the direction followed by passing trains has long been a disturbing factor here in the conduct of double-track roads, it being asserted, on authority, that, aside from the element of danger, the cost of remedying this particular evil consumes as much as thirty to forty per cent of the entire annual expense of track repairs on such roads. The main causes of such lengthening are variously supposed to be the thumping of the rolling stock against the rear ends of the rails, the friction of wheels under the stress of powerful brakes and weights, and the pressure of wheel flanges against the outer rail of curves. Single-track roads are not similarly affected, because the passage of trains in both directions acts as a natural corrective of the evil.

Through this forward motion of the rails the safety space between rail ends disappears and any increase in temperature is liable to result in the spreading or bulging of the track, as also the twisting and tipping of sleepers and ties, an effect especially noticeable and injurious near switches and frogs. At sharp grades and curves it may happen that one rail is moved forward, while the other assumes the opposite motion, thus bringing about a dangerous twisting of the roadbed.

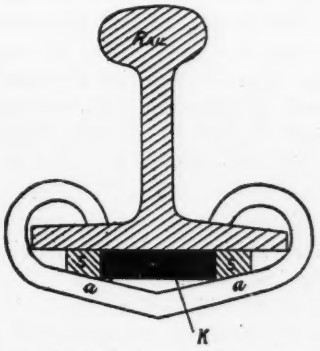


FIG. 1.—CROSS-SECTION OF RAIL AND APPARATUS TO PREVENT CREEPING.

Recently an invention has been perfected by an engineer named Dorpmüller, which is claimed to have completely solved the difficulty.

The apparatus consists of an iron clasp or clamp (indicated on the accompanying sketches by the letter *a*), the curled ends of which hug the base flanges of the steel rail from the top and which firmly hold against the bottom of the rail a key or wedge of iron (*k*), the wide end of which is calculated to rest firmly against the side of the next adjoining sleeper. This wedge again drives two pieces of iron (*s s*) against the slanting bottom of the clamp, thus automatically and successfully holding in place the entire apparatus by means of the very force that is sought to be counteracted. Through the application of a sufficient number of these clamps at points where the track appears particularly endangered, the entire roadbed is rendered steadfast, and the movement forward of rails has been successfully overcome.

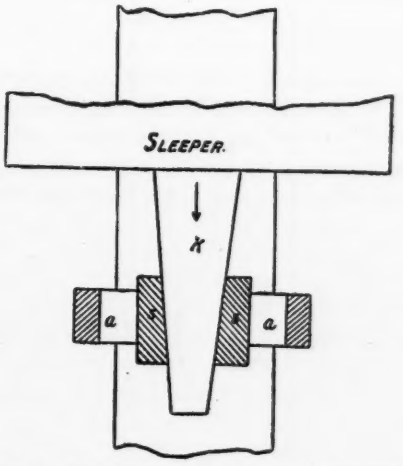


FIG. 2.—HORIZONTAL SECTION OF APPARATUS TO PREVENT RAIL CREEPING.

The lines between Aix la Chapelle and Düsseldorf and between Cologne and Herbesthal have been equipped with this apparatus. Severe tests have been made at points where the trouble has heretofore been greatest, and it was found that by applying eight clamps to each fifty-foot rail, laid upon a gradient of 1.37, and where fifty-four trains per day passed thereon, practically no movement of track or rails took place during a period of eighteen months, while, without this appliance, it had been necessary to restore normal conditions about every three or four weeks.

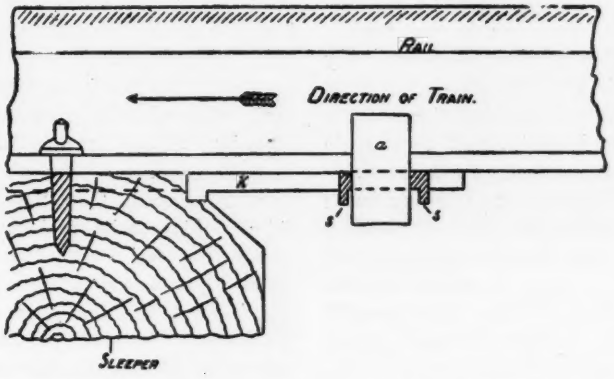


FIG. 3.—SIDE VIEW OF RAIL AND APPARATUS TO PREVENT CREEPING.

Should further details be desired, they could doubtless be had from the inventor or from the Zeitschrift des Vereins deutscher Ingenieure, Berlin.

ELECTRIC RAILWAYS—THE ART AND THE MEN.[1]

BY FRANK J. SPRAGUE.

To Thomas Davenport, blacksmith, of Brandon, Vt., belongs the honor of making the first recorded experiment, for in 1834 he showed at Springfield, and again in Boston, a toy model, mounted on wheels, and propelled a few feet on a circular railway from a primary battery. This was but one of his accomplishments, for history relates that in a few years he constructed and put into operation no less than a hundred motors of a type now of course obsolete.

Four years later Robert Davidson, of Aberdeen, constructed a locomotive which was tried on the Edinburgh-Glasgow Railway. In 1847 Moses G. Farmer, one of the most prolific of early experimenters, exhibited a small model at Dover, N. H., and three years later in Boston Thomas Hall showed an automatically reversing motor. A year later Professor Page, of the Smithsonian Institute, with congressional help, equipped and ran a car on a road near Washington. All these, and various other experiments of those early years, depended on the use of primary battery, and hence, irrespective of the shortcomings of the machines themselves, commercial success was impossible. It was not until the invention by Pacinotti in 1861 of the continuous-current dynamo, improved and developed by Siemens, Whitestone, Varley, Rowland and others, and the discovery of the reversible functions of the dynamo electric machine, said to have been made originally by Pacinotti in 1867, but certainly proved, some say at first by accident, by Gramme and Fontaine in 1873, that the key to the transmission of energy was found.

Between this date and the beginning of experimental work on modern lines I find a mention of but one name, that of George Green, a poor mechanic in Kalamazoo, Mich., who built a model operated from a battery through the track and an overhead wire.

About four years later three inventors, whose names are known the world over, became almost simultaneously and independently interested in electric railways. These were Dr. Werner Siemens, Stephen D. Field, and Thomas A. Edison. To the former belongs the credit of actually operating the first road supplied from a dynamo which carried passengers, as shown at the Berlin exposition in 1879. A toy-like affair it was, a miniature locomotive pulling three small carts seating about twenty passengers. As illustrating how trivial facts connected with early experiments stand out, one of the younger Siemens recently told me that these small cars being provided with division arms, quite some anxiety was displayed when it was discovered that to accommodate the German Emperor, a man of large physique, one of them had to be removed. I note that this practice has been extended to our subway to provide room for our everyday emperors.

The demonstration by Siemens was followed by other exhibition equipments, and in 1881 by the installation of a short line with one car at Lichterfelde near Berlin, the first commercial road. This was followed by others by the same house, and an ambitious project for an elevated railway in Vienna.

In 1879 Field filed a caveat, showing an electric railway taking current from a wire enclosed in a slot, and in 1881 made experiments in Stockbridge, Mass. In 1880 Edison, utilizing one of his old Z lighting dynamos, constructed and operated a small road in a yard of his laboratory at Menlo Park, using the two rails as conductors.

About this time various other inventors began to take up the study of the subject, and Jenkins, Ayrton and Perry began the development of telpherage or automobile railways. Chance is oftentimes responsible for inventions, and perhaps for my own entry into the railway field, for although I had become interested as early as 1879 in the possibilities of a somewhat eccentric motor, it was not until 1882, when my duty as a member of a jury at the Crystal Palace, Sydenham, London, took me on the underground railroad, that I seriously considered this special problem. This interest took the form of a project for operating that road by adopting the general system of constant potential supply developed by Edison for electric lighting, and using the tracks as one conductor, an overhead one supported by the roof as the other, contact with the latter to be made by a roller carried on a spring-supported saddle, a forerunner of the modern trolley.

In the year 1883 Field and Edison combined forces, and exhibited at the Chicago railway exhibition a locomotive called the Judge, which ran around the gallery, the motor used being a Weston electric light dynamo.

Siemens also installed the first line in Great Britain, that at Portrush, Ireland, and another short line was installed at Brighton by Magnus.

Charles J. Van Depoele, a woodcarver by trade, but an electrician at heart and an indefatigable worker, began experiments at his factory in Chicago, using a five-light dynamo on a car platform, and taking current from a wire laid in a slotted plank, following this by a short line at the Industrial exhibition.

It was in 1883, too, Leo Daft began his labors at Greenville, N. J., following them that fall with the operation of the Ampere at Saratoga, and soon after with small roads elsewhere. Bentley and Knight began their experiments in the yards of the Brush Electric Company, and in the following year they installed a short conduit line in Cleveland, which was spasmodically operated during that winter. In the latter year Van Depoele operated a road at the Toronto exhibition, and about that period Anthony Renkenzaun, a particularly able engineer, actively conducted storage battery work abroad.

The year 1885 was prolific. Daft began operations in Baltimore on the Hampden branch of the Union Passenger Railway with two locomotives, this being, I think, the first regularly operated railroad in the country. His ambitious work on the Manhattan Elevated with the Benjamin Franklin was a remarkable effort, but like all then made on that road, as well as those made a number of years afterward, met with but little encouragement.

I had now resumed railway studies, and began the construction of motors for experiments on this road, these being used first on a private track in an old sugar refinery, and then on the Elevated in May of the following year, but on somewhat different lines, for the motors were centered on the axles of regular trucks geared to them and freely supported at one end, this practice being subsequently generally adopted, but after some months I, too, quit, and then tried the construction of a locomotive car.

Meanwhile Van Depoele had begun operations at South Bend and Minneapolis, Henry had installed a small line in Kansas City, and Short had embarked on experiments with a series system at Denver.

This and the next two years saw active work by all of us who had ventured in this new field, some with central station and others with storage battery supply, the principal roads actually installed being by Van Depoele and Daft.

In 1887 the equipment of the Richmond Union Passenger Railway fell by

[1] Abstract of an address at the annual dinner of the American Institute of Electrical Engineers, New York, February 8, 1905.

good fortune to my company, and that year may be fairly said to mark the beginning of active development.

Looking back these nearly twenty years, I am reminded of the cry of the prophet, "Oh, ye of little faith," and yet I, for one, and I think I may speak for most of the others, would not have had it otherwise, for let me tell you, my younger brethren, whether it be on the battlefield or in civil pursuits, there is no victory so sweet as that wrung from almost certain defeat; and if you need encouragement in present or future struggles, let me bid you ask of the living and the dead the record of 1879 to 1888. They will tell you of cynicism, ridicule and unbelief, of unremitting labor and disappointment, of poverty, sickness, wreck and ruin, but they will also tell you of their inspirations, of exalted moments, of hopes realized, of victories won.

The adoption of electricity on the West End Road by Mr. Henry Whitney, to whom must be awarded the credit for initiating the modern consolidations of street railways, was followed by a period of extraordinary activity in commercial and technical development, in which for a time the Sprague and Thomson-Houston companies were principal competitors.

This development has no parallel, and to the query now came it so, I answer: it was due to the genius of opportunity, the crying needs of transportation, and the quick wits which saw the coming light.

The ten years following Richmond were marked by continued and vital improvements in apparatus and equipments, among which must be specially mentioned the introduction of the carbon brush by Van Depoele, the Thomson magnetic blowout by Potter, form-wound armatures by Eichmeyer, and the combination of resistance and series parallel control, the latter originally proposed by Hopkinson in 1880. Cast iron gave way to steel, two-pole motors to four, open-type motors to enclosed and protected, and the single-gear again resumed sway.

For a long time the single trolley held, and for much of the future will continue to hold, first place, because of simplicity, effectiveness and minimum first cost.

The Allegheny and Boston conduits had been abandoned, but in 1893 a short line was tried in Washington on the Love system, and in the following year work was begun in New York on the Lenox avenue line and carried to that successful conclusion which warranted its adoption there, under the auspices of William Whitney and Henry Vreeland, and soon after in Washington under Connett, although a line had been in operation at Budapest for some time.

Train operation as distinguished from that of single cars began on the South London road in 1890, and this was followed by various proposals for the New York elevated, the installation of the intramural road at the World's Fair, Chicago, the equipment of the Lake street elevated, and by other installations. Heavy locomotives were built in 1892 and 1893, both for experimental work and for regular operation in the Baltimore & Ohio tunnel.

Meanwhile the limitations of direct-current motor work were greatly extended by the development in polyphase transmission, and the transformation into continuous current at lower pressure by static and rotary transformers, through the work of Tesla, Stanley, Scott and others. The first actual proposal to use this combination was made in 1896 by our past president, Mr. Arnold, and it has now become the standard practice.

One immediate result was that rapid introduction of comparatively long distance high-speed interurban lines, which although generally operating single cars have had such an influence upon steam railways and been so instrumental in welding together urban and rural communities.

But with all the advances made, train operation was still limited, and largely because of adherence to old established locomotive practice. Having been for a long time engaged in developing the indirect control of elevators, the thought suddenly flashed upon me that trains could be better operated by simultaneously operating a number of controllers, each with its own motors, thus allowing any desired aggregation of independent units in a train having all the characteristics of the individual. This, known as the "multiple unit" system, received its baptism on a train of cars at Schenectady in 1897, and was first adopted at the South Side Elevated of Chicago, although I had for a long time pleaded for an opportunity to make a demonstration on the Manhattan Elevated, as I had pleaded for many years for electric operation in all rapid transit work. It was, of course, a logical development, and has now received the stamp of universal recognition. Some measure of its practical importance may be gathered from the statement that by reason of the increase in capacity alone, it has the potentiality of adding at least fifteen millions of dollars to the capitalized value of the subway.

Up to the present time almost all important work has been conducted with continuous-current motors at moderate potentials, but on any large system this requires the transmission of energy primarily from a long distance by alternating current, and reduction to a lower pressure and transformation at substations.

To economically extend the radius of electric operation from these substations, it is, of course, essential to work at comparatively high pressure, and in order to attain this end without running into serious or assumed difficulties with continuous-current motors, as well as to get rid of the moving element in substations, the activities of leading engineers, among whom must be mentioned Tesla, Finzi, Lamme, Eichberg and Steinmetz, have for some time been bent on the development of the alternating-current motor. The earlier attempts in this direction were for a machine without a commutator, that is, one that could be operated by polyphase currents, and it is on these lines that the admirable work of the Ganz Company and the high-speed tests on the Zossen military line in Germany have been carried. But the recent developments, in this country at least, have been almost wholly along lines of single-phase operation in order to maintain the simplicity of the present trolley line practice. A large measure of success has already been attained in this direction, so much so that the single-phase motor can now be accepted as an essential contribution to railway operation, its adoption being a matter of individual determination. In this connection I should add that Mr. Arnold was one of the earliest and has been one of the most consistent advocates of single-phase operation.

Such is the brief and imperfect review of an industrial development whose spidery web has enmeshed our modern life, and is rapidly changing the current of our affairs. And where now are the men who have borne the brunt of the fray? Werner Siemens long ago has passed to his reward, after a life of useful activities. Charles Van Depoele, too, has gone, leaving behind an ineffaceable record. Then Reckenzaun, Henry and Short joined the vast majority. But Field and Edison, now, thank God, happily recovering from a serious illness, and Daft are with us. And so are most of my own corps, the boys to whom my heart ever goes out in gratitude and affection, who stood loyally shoulder to shoulder and fought a good fight in the old days. One of my trusted associates, Dana Greene, found sudden death in the icy waters of

the Mohawk in the midst of a splendid career, but Oscar Crosby, wearing the laurels of an intrepid explorer, has come out of the desolate East after achieving fame and nearly immortality in the frozen peaks and solitudes of the Himalayas.

A younger generation is coming to the front, and new and splendid fields await them. The hum of the motor is no longer a song only of emancipation, but a hymn of praise, paen, challenging on its chosen ground the locomotive whose throbs have been rightly called the heartbeats of civilization.

Is it a siren's song? Not if listened to soberly and with the guide of experience. And perhaps I may on this occasion say a few words in answer to that everpresent query, "Will trunk lines be operated electrically?"

We stand in the midst of the solution of grave and complicated problems, incident to the demands of our local situation. Terminal improvements on the New York Central, Pennsylvania and Long Island railroads, costing nearly eighty millions of dollars, and making possible chiefly because of electric traction, supplementing the equipment of the surface, elevated and underground railways, may well dazzle the mind, and lead to hasty conclusions, forgetting that in so far as these problems are out of the ordinary they are many of them special in character.

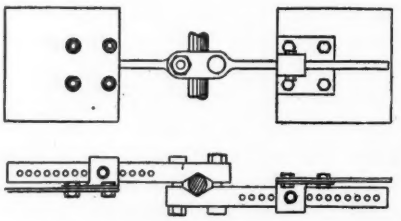
We have thirty thousand miles of line to the credit of the electric railway in this country alone, but the character of the traffic and the service performed by these lines is absolutely distinct from that pertaining to trunk-line operation. Two hundred thousand miles of road and over half a million miles of track are in its grasp, a prize worth fighting for, but not easily won. Understand, I do not for one moment take the position that a railroad, no matter how large, can not be operated electrically. It can be. Energy of that amount can be transmitted for any distance commercially required. Motors of large power and aggregated into combinations of capacity greater than that of any steam locomotive can be built and perfectly controlled.

And with great power there is, of course, the possibility of high speeds, but a well ballasted track, free from curves, grades and grade crossings, a reserved right of way, perfect brakes and signals, infrequent stops, and favoring outward conditions are equally essential to steam or electric traction of the first order. It is sustained, not extraordinary maximum, speed which is required in practical service, and sustained speed is a matter of finance.

What, then, will determine the future? Solely this financial factor, as it must the future of any other great industrial problem. When savings in operation and the increased return from traffic on any road will more then pay a fair dividend on money invested for electrical equipment, then and then only will trunk lines, great or small, be operated electrically. As I have often stated, the problem resolves itself into a question of relative density and the character of load-factor, and these essentials are, of course, vitally connected with the allowed working potential on a trolley line. There is a tendency to assume that the limitation of operations by continuous-current motors has been reached, and that the only possible large development is with the alternating-current motor. I say God speed the alternating-current motor, and every mile it adds to the radius of action is a mile to the good, but speed also its sister, which has as yet by no means reached the limit of its usefulness.

Absorption Dynamometer.

In the *Electrical Engineer* (London) for February 3, a simple absorption dynamometer, designed by Mr. W. G. Walker, is described. As will be seen from the accompanying illustration, the dynamometer is merely a centrifugal fan, consisting of two arms which may be bolted



WALKER ABSORPTION DYNAMOMETER.

to the shaft of the motor, and which carry two vanes. These vanes may be adjusted radially, or vanes of different size may be substituted quickly. When once the dynamometer has been calibrated in a certain position, the power absorbed for every speed is known.

Convention of the International Association of Municipal Electricians.

At the meeting of the executive committee of the International Association of Municipal Electricians, held at Erie, Pa., February 13, the date for the convention was set for August 29, 30 and 31, 1905.

Determination of the Commercial Efficiency of Continuous-Current Machines.

The *L'Industrie Electrique* (Paris), in its issue of January 25, prints a translation of an article by M. S. Baldine, from the *Electritchestvo,* in which the well-known Hopkinson or circulating test for determining the efficiency of continuous-current machines is examined. The test, as usually made, involves several sources of error. The currents in the two armatures are equal, but this may be allowed for by computation. However, the iron losses are not the same, since the voltage of the generator must be somewhat higher than that of the motor. A method of correcting this is suggested. It consists of connecting in the circuit between the motor and generator an auxiliary supply, such as a storage battery, and in series with this is a regulating resistance. Then, for any particular load, the loss of potential due to leads and armature resistances is computed, and the auxiliary adjusted until this loss of potential is just compensated by the auxiliary source of electromotive force. This being done, it is known that the iron losses in the two machines are the same, and the difference in the copper losses may be allowed for, as indicated above. The method of computing the necessary auxiliary potential for any particular load is given, as well as the equations for the efficiencies of the two machines.

The Office of the "Brooklyn Eagle."

The *Brooklyn Eagle* has recently enlarged its fine building and has added every modern convenience, not neglecting the many facilities provided through the medium of electricity. Its tower is illuminated nightly by some 1,500 incandescent lamps which are used on special occasions for signaling. The *Eagle* presses are controlled by the Kohler electric system, and each press is operated by individual electric motors, as is every piece of machinery in the entire building. The use of that wonderful time-saving invention, the telephone, is reduced to a science in the large and convenient reporters' room. Each reporter's desk is wired so that the portable telephone can be brought to it and conversation carried on without his leaving his work.

A party of New York newspaper men and electric light and electric railway officials were shown through this interesting building on Saturday last under the guidance of Mr. Herbert F. Gunnison, the publisher of the *Eagle.* The party previously enjoyed a luncheon held at the Hamilton Club, presided over by Dr. St. Clair McKelway, the editor in chief of the *Eagle.*

FUEL ECONOMY IN STEAM POWER PLANTS.[1]

BY WILLIAM H. BOOTH AND JOHN B. C. KERSHAW, F. I. C.

INTRODUCTION.

In presenting this paper the authors are aware that economy in most or all electrical power plants, as usually understood, is at present unattainable. The lighting station, the load of which at every moment of its working hours can, with care, be arranged to suit the economical load of the running plant, is nevertheless seriously handicapped by the very short length of time during which the total plant is at work. The possession of a really durable and efficient storage battery would raise the load-factor of the plant probably eightfold. The traction power-house, the load-factor of which, for tramway work, varies approximately with the cube root of the number of cars run, can not be worked economically, because, though all the power in the station must be run all the working hours, excepting, of course, necessary spares or stand-by plant, yet the load on the running plant varies from a maximum to a minimum every few minutes, and the mean load of the plant, except in the case of systems of several hundred cars, is but a small proportion of the total maximum load, and the steam engines at least must be wasteful. Here again economy in its fullest sense is a question of accumulators.

The authors assume that the fullest economy of first cost, and more especially of running cost, is recognized by all station engineers as only obtainable, in the present state of knowledge, by means of a battery. But they are also aware that the battery is so far from perfect that its adoption in any case must still be a matter of grave and careful deliberation, and that the greatest economy ideally possible is too controversial to enter into in this paper, save incidentally. But there are numerous economies possible in every power plant, and an endeavor will be made to point these out in the hope of stimulating the search after possible and practicable economy, to suggest thoughts on which all station engineers may work—thoughts many of them suggested to the authors by engineers who have directed their own energies in certain directions more than in others. Economy, commercially considered, is not identical with economy of first cost, nor yet with economy in fuel or wages. Nor can commercial economy be defined even as that compromise which makes the best return on the outlay, for there are other considerations which are sometimes paramount.

It is, for example, justifiable to economize plant in a traction station down to such a point that, at occasional special loads, the cars shall run a small percentage slow. But the parallel happening in a lighting station is altogether undesirable and defeats its own ends, because the public who use current are not yet trained to switch off some lamps when current fails. In all which follows, therefore, it must be understood that every means to economy that is put forward must be considered afresh for each particular case, for its adoption may be good or otherwise, according to the company in which it finds itself, and, though the authors are particularly concerned in fuel economy pure and simple, they are not unmindful of the discounts to be made on account of commercial considerations.

Steam-power economy is to be secured by attention to fuel and its combustion, feed water and its treatment and heating, furnace design and arrangement, steam treatment and its use in suitable engines.

The subject divides itself into the several heads as follows: (1) feed water; (2) fuel; (3) boilers and furnaces; (4) steam; (5) waste gases; (6) draught. In such a paper statistics would only lead to controversies that might obscure the intention of the paper, which is rather to emphasize principles than to indicate beaten paths.

FEED WATER.

Most electrical engineers are now ready to admit the importance of attention to the physical and chemical characteristics of their feed-water supply, and they recognize the impossibility of obtaining the highest efficiency from their boilers if the water is passed into them without preliminary heating, carrying all the original suspended dirt and dissolved impurities. Only very few natural waters are fit for use in steam boilers without some preliminary treatment; chemical examination can alone reveal whether this treatment is required and what must be its character. It is not the authors' purpose to go at length into the theory and practice of water softening for steam-raising purposes, and they will only deal very briefly with a few of the more important points arising in a consideration of the subject. The practical side of the subject was dealt with very adequately by Messrs. Stromeyer and Baron in a paper read before the Institution of Mechanical Engineers last session.

Analysis—The examination of a water intended for steam-raising purposes should cover its acidity or alkalinity, presence of oily or fatty matter, total solids, temporary and permanent hardness. A trained chemist is required for this work. The examination of the water supply should be repeated at monthly intervals, since changes occur in the composition of all natural waters, according to the period of the year and the rainfall. Water taken from rivers or streams near the coast is subject to contamination by sea-water at the periods of flood tide in the spring and autumn, and this danger must be recognized and guarded against.

When softening apparatus is installed, whether of the automatic or intermittent type, daily tests should be made of the water leaving the apparatus, since there is grave risk in many cases of excessive amounts of chemicals being used for softening. This excess produces priming and other evils in the boilers. The authors have seen at a north country works an ingenious automatic arrangement of twenty-four vessels for retaining this number of separate samples of the water during the day's work, each one filling in succession and requiring one hour for this purpose. The chemist at these works spends half an hour each morning in this sampling place (which is kept locked), and tests in this time selected samples of the previous twenty-four hours for alkalinity and hardness. Some check of this kind is imperative, since even the most reliable types of automatic softening apparatus are apt at times to get out of order, and variations in the composition of the water supply, as already noted, occur during the spring and autumn months of the year.

Softening Apparatus—All waters containing more than fifteen English degrees of total hardness (*i. e.*, an equivalent of fifteen grains of calcium carbonate per gallon) should be subjected to treatment with chemicals before use in the boilers; and in large steam-generating plants it would probably pay to put in a softening apparatus when the water employed tests above ten degrees of hardness.

The addition of "boiler compositions" to the feed water as it enters the boilers is unscientific and bad. A boiler is designed for making steam, and not for carrying out half a dozen other operations, which sellers of "secret" compositions and unwise engineers sometimes attempt in it. External treatment of the water in an apparatus, which permits removal of the deposit before the water enters the boiler, is therefore an essential condition of scientific steam-boiler management. The

[1] Paper read before the Institution of Electrical Engineers, January 12.

authors do not propose to discuss the relative advantages of automatic and intermittent softening apparatus. Each type has its advantages and disadvantages, but scientific control is required with one, as with the other, to obtain the best results; and, in the absence of this, boiler troubles are certain sooner or later to ensue.

Scale and Grease Troubles—A thin coating of scale upon the boiler plates is advantageous, since it protects the iron from pitting and corrosion. When this coating has increased to one-twentieth of an inch in thickness no further advantage is gained, and the rate of the heat transfer through the plates is diminished enormously as the scale increases in thickness. The heat-conducting power of scale is stated by various authorities to be between one-thirtieth and one-hundredth that of boiler plate, and should the scale contain oil, its conductivity for heat is still further reduced. The presence of oily matters in scale can be easily detected by heating a small portion of the scale upon a platinum spatula in a Bunsen flame; the scale, if it contains oil, chars and gives off a disagreeable odor under such conditions. Oil in the water supply, and oily scales are a cause of pitting and corrosion, since animal and vegetable oils yield decomposition products of an acid character, at temperatures which may easily occur within the boiler. The examination of the water supply must, therefore, include tests for oily and fatty matters, when water from the exhaust is employed. When mineral oils are used for lubrication this danger, of course, is not so great, since these oils do not yield fatty acids on decomposition; but even in this case it is the better plan to keep the oily matters out of the boilers by efficient filteration. The addition of caustic soda to the feed water as it enters the boilers, in order to saponify the fatty matter, is not to be recommended, since soapy water leads to priming and other troubles only a little less serious than those caused by oils. Although the complete separation of oil and grease from feed water is not a simple matter, it can be effected with well-designed apparatus intelligently worked. As a guard against pitting and corrosion, the authors recommend the use of zinc slabs and rods, bolted in suitable positions to the stays and angle plates of the boiler. The action of this metal is too well known to require comment; and even if its electrochemical action does not come into play, these metal projections into the body of boiling water will help to promote regular steaming in the boiler.

Preheating and Thermal Storage—The advantage of feeding the boilers with water approaching as nearly as possible to the boiling temperature is now fully recognized. Not only does this promote more regular steam generation and, therefore, the efficiency of the boiler plant, but it also accelerates the softening process, since the chemical reactions upon which this is based take place much more rapidly in hot solutions than in cold or warm ones, and the precipitates obtained are more easily settled out in the former case.

The only question regarding the value of preheating upon which engineers are now disposed to differ, relates to the use of live steam for this purpose. It is admitted that all the waste heat of a boiler plant, whether of the exit chimney gases or of the exhaust and condensing water, should be utilized, if possible, in the feed-water supply, and that the heat obtained in this way is clear gain. But, the advantages of using live steam, in addition, for heating the feed water up to 212 degrees Fahrenheit, or above that limit, as in the thermal storage system, is not by any means fully recognized, and there is still a disposition to regard this method of using live steam as uneconomical and wasteful. The authors do not agree with this view. The heat of the live steam is retained in the feed-water heater, and the advantages to be gained by having all the water heated to a temperature of 212 degrees Fahrenheit or higher, far exceed the slight loss of heat which occurs by condensation and radiation from the connecting pipes between the preheater and the boilers. Of course this loss must be minimized by placing the feed-water heaters close to the boilers.

The real cause of the increased efficiency which independent authorities (as, for instance, Mr. Miller and Colonel Crompton) assert has been obtained from boilers fed with water at or above 212 degrees Fahrenheit, is not yet settled. If water containing solid matter in suspension be heated in a glass vessel, it can be observed that convection currents are set up which continue until the boiling temperature is attained. These currents must necessarily absorb some portion of the heat energy of the fuel, and convert it into mechanical work. A possible explanation of part of the gain observed when feeding boilers with water at or above 212 degrees Fahrenheit is, therefore, that the loss of heat due to the performance of merely mechanical work is avoided, and the whole of the heat energy of the fuel is devoted in the boiler to the conversion of the water into steam. In the feed-water heater as usually designed, convection heating does not take place to any great extent, the water being heated by falling through the steam in the form of mist or spray.

This explanation finds some support in a paper read by Mr. Hamilton before the Belfast Mechanical and Engineering Association in 1902, and quoted in a leading article in the *Engineer* of August 19, 1904. In this paper Mr. Hamilton pointed out that the hotter the water inside the boiler the greater is the amount of heat which passes through the boiler plate per unit of superficial area, the measure of relative efficiency being the gain in temperature when not steaming and the water evaporated when steaming. The increased heating power when steaming represented a gain of about 100 per cent in the normal heat-transmitting power of the boiler plates.

The subject is well worth more study than it has yet received, for the facts relating to the gain in boiler efficiencies when fed with water at or above 212 degrees Fahrenheit seem indisputable, and when a satisfactory explanation of the cause has been given engineers will no doubt be ready to adopt preheating and thermal storage plant to a much greater extent than is now the case. The steam boiler of the future is likely, in fact, to be specially designed for this double duty of preheating its feed water and providing steam; and it is interesting to note that one or two boilers of this type have already been designed and patented.

FUEL SUPPLY.

The importance of the fact that fuel represents fifty per cent of the total works cost in the generation of electricity, and that from ten to twenty per cent of this outlay can be saved, is often ignored by engineers when contemplating the low price at which they have placed their fuel contracts. It is held that because fuel is cheap, therefore it may be wasted with impunity; and much of the inefficiency to be found in the boiler houses of electricity works is to be traced to this fallacy.

But a ten per cent saving on the total works costs is worth effecting even when these costs are exceptionally low; and systematic sampling and testing of the fuel would in many cases be found to save money. The supplies of fuel, whether cheap or dear, ought, therefore, to be subjected to regular sampling and testing. A check upon the colliery firm or coal merchant supplying the fuel is afforded by the laboratory examination, and this is useful not only in maintaining regularity in the quality of fuel supplied, but also in affording a basis for the new contracts

which are from time to time made. The recent letter of Mr. C. E. C. Shawfield, of Wolverhampton, which appeared in the *Electrician* of October 7, 1904, is proof that at last the truth of these statements is being recognized; and the only criticism the authors have to make on this letter is, that Mr. Shawfield does not appear to recognize the need of employing specially trained men for sampling and testing work.

Sampling—The sampling of fuel requires care if the sample is to be representative of the bulk supplies, and much of the distrust in engineers' minds relative to the value of laboratory examination of fuels, has been due to lack of expert control of the sampling operation. A copy of sampling rules is, therefore, included in the appendix of this paper, and it is recommended strictly to adhere to these when sampling fuel for analysis. It may be considered a striking fact, but it is none the less true, that a sample of only one pound in weight, when properly taken, can be truly representative of 50 or 100 tons of coal; and from such a one-pound sample a trained chemist can, by further grinding and reductions, obtain a sample of two grammes or less which shall be equally representative of the original bulk of fuel.

Whole shiploads of copper and iron pyrites containing several hundreds of tons are regularly sold on the results of the analyst's tests made with only one-half gramme of ore, without any disputes occurring between buyer and seller, and it is certainly not impossible to obtain equally accurate sampling and testing in the case of fuel. But, as already said, scientific knowledge and control are required in the sampling operation, and lacking this no fuel test is worth the paper upon which it is written. The idea should therefore be given up that a few shovels of coal taken from any part of the fuel heap and placed in a box constitute a "sample," and some personal time and attention should be devoted to the rudimentary principles of sampling and to the training of men specially for this work.

A regular and constant check upon the fuel supplies can then be obtained by having daily samples of the fuel taken. These samples can either be tested separately, or an average can be obtained at weekly intervals, by mixing all the daily samples and reducing these to smaller bulk in the manner described in the sampling rules. When a coal-conveying plant is installed, an automatic sampling arrangement should be added to it.

Testing—The testing of fuel for technical purposes should cover moisture, ash, coke, volatile matter and calorific value; the last being calculated from the proximate analysis and also ascertained by burning from one-half gramme to two grammes of the fuel in one of the various forms of fuel calorimeters. Men without training in chemical analysis should not undertake this kind of work. Fuel calorimetry is difficult, and even trained chemists require practice and experience in it before trustworthy results can be obtained.

Placing Fuel Contracts—It is often found that the fuel which yields the best laboratory test results is not that which produces the most steam per pound of fuel when burned under the boilers; and a tendency is manifest to make use of this fact as an argument for dispensing altogether with fuel analyses and calorimetric tests, when placing fuel contracts. This view is a superficial one, and is wanting in a true appreciation of the factors which govern the combustion of fuel under the boilers.

Every type of boiler-surface is naturally best fitted for burning a specific kind of fuel, and by empirical trials this fuel may, of course, be found. When fresh contracts are to be made two courses are open; either to obtain a fuel as nearly as possible equal in physical and thermal properties to that last contracted for—or, to obtain a different fuel and adapt furnaces and draught to the new fuel. Now the chemical and calorimetric examination is of the greatest value in either case. It simplifies the search for a fuel similar in all characteristics to that last used, since if the percentage of ash, volatile matter, coke and fixed carbon be determined, the desired fuel can be selected without recourse to the troublesome and expensive steam-raising trials under the boilers. If, on the other hand, another type of fuel be selected owing to its much lower price, the laboratory examination will be a guide to the changes required in furnace construction, methods of firing and draught, in order to get smokeless combustion and high efficiencies, when this fuel is burned under the boilers.

Too little attention has certainly been given in the past to this question of adapting the furnace construction and methods of firing to the fuel, and whatever boiler makers chose to recommend has been much too readily accepted. Most of the electricity works where high-priced fuel is now being used, because it is asserted that steam can not be kept up or that smoke is produced when burning cheaper fuel, are simply playing into the hands of the South Wales colliery companies.

The authors assert that with suitable furnace construction and scientific control, bituminous fuels can be burned without causing smoke troubles and with high efficiency under every type of boiler, and that great savings in fuel costs could be effected in this direction. But the furnace construction must be adapted to the fuel, and it is absurd to suppose that furnaces designed for burning anthracite or semi-anthracite fuel will satisfactorily burn fuels containing thirty per cent or more of volatile matter. The percentage of volatile matter which a fuel gives off when heated is in fact a measure of the size of the chamber required for its complete combustion, and it is here that the laboratory examination of fuel yields results of the greatest value. That such an examination is still regarded as unnecessary and of no help in the placing of fuel contracts, is clear proof of how much has still to be learned in the scientific control of steam plant.

AIR SUPPLY.

The advantages to be gained by a preheated air supply are very great, and it is surprising that hitherto so little attention has been given to this subject. In 1881 Hoardley, in the United States, published details of some unfavorable experimental trials relating to the use of preheated air, and possibly these unsuccessful results may have deterred others from experimenting along similar lines. But the gain in economy and efficiency by raising the combustion temperature inside the furnaces by the use of heated air is great, especially if heat otherwise wasted is applied to heat the incoming air.

This ideal system would be to reduce the exit flue gases to atmospheric temperature by means of economizers, air heaters, and preliminary feed-water heaters—chimney draught being dispensed with and the draught produced by fans. The preliminary feed-water heaters would be placed last in such a system, and the whole of the remaining heat would be removed from the exit gases by spraying the water through them, or by use of a tower filled with tiles or flints.

Little or no unconsumed carbon would be produced under the conditions obtaining with a very high temperature in the combustion chamber of the furnaces, and the sulphur dioxide and CO_2 absorbed by the feed water would be neutralized in the water-softening operation. It must be

remembered here that the sulphur would finally appear in the boiler as sodium sulphate, but the authors suggest that it (the sulphur) might be recovered in some way, and made a source of revenue to the feed-water purification plant. The air-heater would be of the type used in the regenerative gas furnace—lengthened contact with a considerable surface of heated brickwork being necessary to heat air, which is a poor conductor of heat and demands time for its temperature to be raised.

As regards the thermal advantages of heating the air used in the combustion process it may be pointed out that from twenty pounds to twenty-five pounds of air are usually required per pound of fuel burned, and if this air could be raised to 300 degrees Fahrenheit before entering the furnace the final temperature after combustion would be increased practically by a like amount. A gain of 300 degrees Fahrenheit in the furnace temperature is not to be despised.

According to Stromeyer's experiments[1] the usually accepted formula for the relation between the rate of heat transmission (a) and temperature (t) is incorrect, and in place of the former varying as the square of the temperature difference, or $a \sim (t_2 - t_1)^2$, the ratio is expressed by the formula, $a \sim (t_2 - t_1)$. Even though the ratio be not as the square of the temperature difference the formula shows that a much greater efficiency will be obtained from a high than from a low initial furnace temperature.

The most important causes of low initial furnace temperature are excessive air supply to the furnaces and too sudden contact of the half-burned gases with the water-cooled tubes or plates. Larger combustion chambers and refractory furnace linings are the proper remedy for the latter evil, and gas-testing is the check and remedy for the former.

Furnace temperatures might, in many plants, be raised 500 degrees Fahrenheit or 1,000 degrees Fahrenheit by attention to these two points alone, but even then the limit of what is attainable in this direction would not be reached. By the use of a heated air supply in conjunction with closed-in ash-pit and induced or forced draught, much higher temperatures can be attained in the boiler furnace; and should Rowan's suggestion[2] for working such furnaces under two or three atmospheres pressure be adopted, further increases of 715 degrees Fahrenheit and 493 degrees Fahrenheit could be attained. The possibility of obtaining far higher evaporative efficiencies from boiler plants than any yet attained, by intensifying the combustion along these lines, is therefore strikingly manifest, and it is surprising that hitherto so few attempts have yet been made to put these suggestions to a practical trial in new plants or extensions.

The authors have, however, recently inspected one plant where mechanical draught, closed ash-pits and a heated air supply have been installed. This station has recently been designed and erected under the charge of Mr. S. E. Fedden, for the Sheffield (England) corporation at Neepsend, and is at present equipped with two 1,500 kilowatt turbo-generators of the Parsons type. It has not yet commenced full work; but excellent results are said to have been obtained with the same system of induced draught and heated air supply at the older generating station of the Sheffield corporation, and it is believed that these results will be surpassed in the new station. A full description of this plant has already been published.[1]

The limit of improved efficiency possible in this direction is that imposed by the ability of the steel used for boiler construction to withstand very high temperatures under steam pressures of 150 pounds or 200 pounds; but no doubt the resisting qualities of steel plates in this respect could be greatly improved, and the more general use of refractory linings to the boiler furnaces would also assist in meeting this difficulty.

BOILERS AND FURNACES.

The choice of a boiler will depend on the circumstances of each particular case.

There are three general types of boilers:—(a) The large shell type such as the Lancashire and Marine. (b) The large water-tube. (c) The small water-tube.

For long-continued steady work such as electric tramway work the type (a) is good. For lighting work and large installations type (b) is good. Type (c) is suitable for the peaks of loads of short duration, and can be heavily forced without danger.

In every case there are certain stand-by losses to be reduced by attention to air-tight brickwork and heat insulation. The rate of loss can be found by closing the dampers and observing the rate of pressure or temperature reduction of a standing boiler. The losses thus observed may be greater than those from a boiler at work, for they include air-leakage loss, which may be less with a working boiler than with one at rest. That a boiler contains much heat in a large mass of water is no reason why its stand-by loss should be great. Small stand-by loss is rather a question of external heat radiation and of convection by air currents. Hence the importance of tight dampers. The type of boiler to be employed is less a matter of heat storage than of rapidity of steaming from colder conditions. Once the temperature of full pressure has been attained, the boiler containing much water will answer as rapidly as the flash boiler to an increased urgency of fire. The conditions of an electric light station may be held to point to the use of light water-tube boilers of the express type fired by liquid fuel. This policy will be the more suitable as the load peak becomes of greater height and shorter duration. The expense of fuel will be counterbalanced by the staff reduction which a purely mechanical plant renders possible.

The economy to be secured by employing cheap and uneconomical engines for getting over brief peaks of the order of those in a lighting station must not be allowed too great weight in view of the fact that a wasteful engine makes a greater demand on the boilers and too big a saving in engine cost will demand too great an expense in extra boiler power or too large an increase of fuel combustion if the boilers are unduly forced to supply the extra steam. But it may well form a point to be considered whether a boiler that can be heavily forced for short periods is not most suitable for high peak loads. On this point engineers should distinguish between an installation for home and for abroad. Abroad, in many places, one need often only count upon forcing boilers for the few minutes either side of the maximum peak. The same forcing can not be done for hours at a time, as might be required any winter in a big English city during a fog which may last a week. It behooves the designer, therefore, to proportion boiler plant cautiously for lighting work, and somewhat more boldly for mere power work. But he should certainly consider

[1] Memorandum to the Manchester Steam-Users' Association, 1902.

[2] *Cassier's Magazine*, December, 1903.

[1] The *Electrician*, vol. liii, p. 465.

the possibilities of superior fuel used for short periods only.

Where coal is the fuel the provision of a second supply will present difficulties that may be more serious than the provision of more boilers; but with a system of liquid fuel, the conveyance of the fuel to the furnaces is a simple matter, and it may well pay to employ expensive liquid fuel during heavy loads of short duration, if capital outlay is thereby reduced together with rent and attendance.

This seems for Great Britain at least the proper use of liquid fuel, and this view is forced on us by a consideration of the relatively small output of liquid as compared with solid fuel. Any more general employment of liquid fuels would deplete the market and raise prices.

The Lancashire Boiler—This type of boiler has the advantage of larger water contents and will respond to a sudden demand for more steam with less loss of pressure than is possible with boilers containing less water. In every type of boiler the water is at the temperature of the steam and only awaits the addition of its latent heat to become steam. Obviously, therefore, the urging of the fire to greater activity will promote an increased production of steam proportionate to the increase of heat units generated by the fire, no matter what the weight of water in the boilers.

The Lancashire or shell type of boiler has the advantage of small heat-radiating surfaces, especially where several boilers are set in a battery. With most water-tube boilers there are at least two side walls to every two boilers. There are only two side walls to any number of the Lancashire boilers, and heat radiation is confined to the front end and top. The chief disadvantage of the Lancashire type of boiler is the furnace. It is narrow in width, has a low crown of water-cooled plate inimical to good combustion, and it can not be lined with firebrick without considerably reducing its dimensions, nor so far do we know of any very successful lining having been done in this country except in dust-firing.

The shell boiler has a large water surface, and gives off steam quietly and fairly dry. It costs very little to maintain, and, being certain and reliable, can be employed with a less proportion of spares than other boilers. In large installations the advantage of a larger water contents is reduced because the steam output of a dozen or twenty water-tube boilers may average out to a steady curve. But for small stations the shell boiler offers better prospects of steady pressure.

The Water-Tube Boiler—Though this boiler does not possess the steady steaming qualities of the larger shell boiler, this fault decreases as the number of boilers increases. It is more apt to prime, and it has greater liability of stand-by losses and larger radiation losses and maintenance. Being externally fired, it possesses great furnace potentialities, which are easily secured. The water-tube boiler can take full advantage of the external furnace provided that the process of combustion is allowed to be carried out in conformity with the known facts of physics and chemistry.

The Small-Tube Boiler—This boiler is merely another step forward in the process of splitting up the heating surface and reducing water contents. Carried to still greater lengths, it produces the flash boiler.

As the water contents are small steam can be got up quickly from cold water, but even here, as shown in Fig. 1, considerable heat is absorbed by the brick lining of the casing, so that the full output of steam does not begin until the boiler has been some time steaming. Hence the bend at the beginning and end of the coal and water lines in the diagram, showing heat absorbed and given off by the brickwork. These small boilers appear to offer themselves for supplying emergency steam. Fired by liquid fuel, some of these boilers, such as the Solignac, could instantly be put in full work if filled up with fully heated feed water from a thermal store tank. The full fire might be started almost as soon as the water had been turned into the empty boiler.

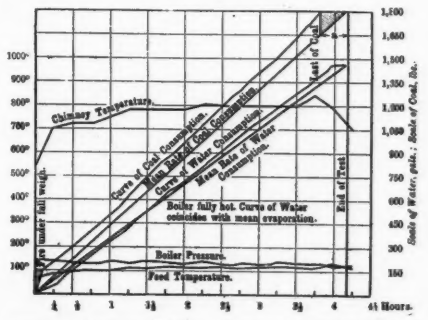


FIG. 1.—BOILER TEST. CURVES SHOWING HEAT STORAGE IN BRICK CASING OF SOLIGNAC BOILER.

FURNACES.

The economy possible from many appliances lies entirely in the possibility of using a cheaper fuel. Unscientifically designed furnaces are unfortunately of lowest first cost. There are certain essentials to the perfect combustion of bituminous coal which, if wanting, render necessary more expensive Welsh coal. The three essentials for the proper use of bituminous coal are a furnace so arranged that the gases given off the green fuel and air to burn those gases shall travel over the length of the fire together, under a draught velocity of not less than thirty feet per second. The mixed gases must have a free unencumbered space beyond the furnace in which to complete combustion, and this combustion will be complete if the third essential of temperature be present.

In shell boilers of the Lancashire type without cross tubes, with roomy brick flues and a 200-foot chimney, a careful hand stoker will burn bituminous fuel without smoke. But this boiler has a water-cooled furnace, and is at just about the critical point as regards smoke production. With a less skilled man or a less active draught smoke will be produced. The presence of water cross-pipes beyond the bridge will render smoke still more easy to produce. Observations of some thousands of boilers, with and without cross-pipes, have demonstrated to the authors the great influence of this detail on smoke production.

The ordinary furnace of the usual types of water-tube boiler is hopeless. No perfect combustion can possibly take place where the gases rise vertically from the grate and pass directly between the cold tubes above. The essential sweeping effect is absent; there is no air mixture, and there is no sufficient temperature. Yet almost invariably this common and inefficient setting is accepted for the few pounds of saving effected in first cost, with the result that the whole cost of the boiler in a year or two is paid away in the shape of more costly coal.

The water-tube boiler, in common with most or all externally fired boilers, can be supplied with a furnace of perfect form, of refractory material, and with suitable air admission. Such a furnace will be smokeless and economical. The water-tube boiler has thus undoubted potential advantages over the shell boiler which has a furnace, perfect it may be in form, but covered with a water-cooled arch difficult to line with refractory temperature conserving material. That air mixture and time are recognized to be factors may be judged from the fact that, in the Belleville boiler, jets of compressed air have been blown into the furnace to produce rapid horizontal movement and mixture of the gases, and to compel combustion by lengthening the path of the gases between the fire surface and the water tubes. The effect of the air jets is to diminish smoke, but they are

a poor and uncertain substitute for proper form of furnace. The familiar classroom experiment of extinguishing a candle by cooling the flame by means of the heat-radiating power of a cone of wire helps one to realize the conditions under which bituminous coal is ordinarily burned.

As between Welsh coal and bituminous, the thermal units of the latter per unit of cost are usually superior to those of the former, and it is easy to understand why large power stations prefer to pay an occasional £100 in smoke fines rather than to abandon one coal for another of twice the cost, though it is less easy to understand why correctly formed furnaces are not employed. In existing stations, with floor lines fixed, basements occupied, and pipes difficult to alter, the change to good furnace conditions may involve considerable difficulty, but in laying out new plant it should be possible to afford the necessary head-room to give good furnace arrangements. The appearance of 99 out of any 100 boiler houses tends to the impression that the designer has acted on *laissez-faire* principles, or has been denied the small additional cost that would be added to the lowest tender which, irrespective of future trouble and expense, rules his employers' judgment.

In running a station, coal is one of the principal items of cost, and the ability to employ cheap coal justifies a reasonable expenditure on furnaces to enable such cheap coal to be used. Only, however, by suitable furnaces can the minimum of cost be secured, and the great economy usual as between Welsh and bituminous coal, is only to be had where furnace forms, draught, and lining are correct. Possible only with care in internally fired boilers, this correctness is easy to obtain with externally fired boilers, but is rarely attempted. Smoke is looked upon as inevitable, and the engineer may make all the smoke he wants if he can show that he has used ordinary plant.

Heating Surface Efficiency—Particularly in water-tube boilers, provision must be made to ensure that all heating surface is effective. Gases from the furnace will flow by the path of least resistance to the chimney, and while this path must not be unduly baffled, the area of the path must be sufficiently small to compel the travelling gas to search out every part of the heating surface.

It is perhaps easier to apply suitable tile baffles where the path of the gases is parallel with the tubes than when it is across them. Since the gases shrink in volume as they traverse the heating surface, the cross-sectional area of this space should be progressively reduced if necessary, to prevent short-circuiting. Where final temperature is high after passing a reasonable area of heating surface, the explanation may be sought partially in this direction.

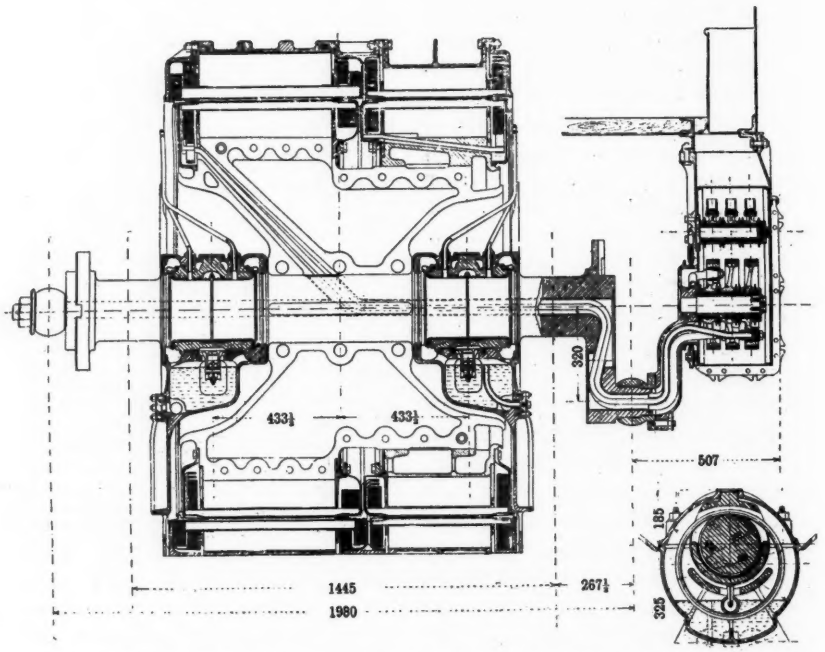
(To be continued.)

The New Valtellina Locomotives.

Three new locomotives have been secured by the Valtellina Railway Company from Ganz & Company, of Budapest. These machines run at two speeds, the change from the higher to the lower being brought about by concatenation. The high speed will be between thirty-seven and forty-four miles per hour, the lower speed being half of this. The frequency is fifteen cycles per second, and the voltage is 3,000.

The motors are three-phase machines, which will give a constant draw-bar pull of three and one-half tons at the higher speed, and six and one-half tons at the lower. The acceleration called for requires that a train weighing 400 tons shall be started on a grade of 1 in 1,000 from rest and brought up to a speed of eighteen and one-half miles per hour in fifty-five seconds. A train weighing 250 tons on the same grade must be brought from rest to a speed of thirty-seven miles per hour in 110 seconds. It is required that the same acceleration be obtained if the voltage fall ten per cent. It is specified that the temperature rise of the motor shall not be more than sixty degrees centigrade at any part after ten hours running at full load.

The motors drive through connecting rods, and are not mounted on the locomotive axles. There are three pairs of driving wheels and two pairs of pony wheels, one at each end of the locomotive. There are two motors on each locomotive, placed between the driving axles. As will be seen from the accompanying illustration, these motors are practically two machines, directly connected, there being on each a double winding, one for high voltage, and the other for low. By means of these windings the concatenation is effected. But three slip rings are needed for this, and, as will be noticed, the conductors are carried through the driving crank. Each motor has two cranks, set at right angles. The high speed of the motor is 225 revolutions per minute. Each rotor is mounted on four bearings. The two inner bearings keep the rotor in its proper position with regard to the stator; the other two fix it with regard to the locomotive frame, and serve as well to support the motor as a whole. The stator is prevented from turning by four bolts, but these support little, if any, of its weight.



Motor on New Locomotives of Valtellina Railway, Italy.

The total weight of the locomotive is sixty-two tons. The useful weight is forty-two tons. The length overall is about thirty-eight feet, and the wheel base, seven feet eight and three-eighths inches. The diameter of the driving wheels is four feet eleven inches.

Mr. Robert B. Porter in a recent lecture before the Society of Arts in London, on the electrification of railroads, stated that when present projects are completed London will have more electric railway mileage than any city in the world and also more capital invested in electric railways than anv other city. About $150,000,000 is at present being expended on the railways in the city.

Pacific Coast Water Powers for Electrical Operation of Railroads.

"The Use of Pacific Coast Water Powers in the Electrical Operation of Railroads" was the title of a comprehensive and interesting paper read before the Pacific Coast Railway Club on January 21, in San Francisco. The paper was presented by Mr. Robert McF. Doble, consulting engineer of the Abner Doble Company, of San Francisco, and was well illustrated with stereopticon views.

The advantages of electric traction over steam for the operation of railroads were considered under three heads: those appealing to the passenger and resulting in an increase of traffic; those pertaining to the centralization of power; and the economies in first cost, maintenance and operating expenses. As the advantages to the passengers, were mentioned the cleanliness and the better ventilation and lighting of electric cars, and the possibility of obtaining higher average and maximum speeds.

Under the advantages of a central power station, the author spoke of the present-day limitations of the steam station and of the possibilities of obtaining power from hydroelectric plants. Particular reference was made to the conditions on the Pacific coast, where available water powers are distributed at frequent intervals all the way from Southern California up into British Columbia. Only a very small portion of these water powers has been developed, even with the stations now operating and the transmission systems now carrying power throughout the central portion of the state, and the conditions would seem to make profitable the operation of at least some of the railroads by electricity. In such a system of distribution as is possible in California, considerable power might be generated by trains descending mountain divisions and thus fed back and utilized in the distribution network.

Under the third heading, reference was made to the saving in the cost and maintenance of track, the possible increase in capacity of existing railroads, the saving of time and labor in the operation of an electric locomotive, its characteristic simplicity and the rapidity with which repairs can be made. The relative reliability of the steam and electric plant was held to be in favor of the latter, especially in consideration of the local conditions in California, where a number of water-power plants feeding into the same distribution system would make exceedingly remote the possibility of breakdown of anything more than an individual locomotive, and the chances for that were only half those for the steam locomotive.

For comparison, Mr. Doble next considered briefly some of the typical modern steam locomotives and took up the discussion of several different types of electric locomotives using direct current. Alternating-current systems, both polyphase and single-phase, were discussed and well-known roads described.

Turning to the achievements of electric traction in California, particular reference was made to the Los Angeles & Redondo Railway, the Pacific Electric Railway, of Los Angeles, and the North Shore and Key Route systems of San Francisco. The North Shore Railroad is of special interest by reason of its being the first and only third-rail line in California, and because of its being operated from a substation which is the terminus of one of the longest transmission lines in the country. The Alto station referred to is 180 miles from the hydroelectric plant at Colgate and 250 miles from the new De Sabla power-house.

As to projected electric lines on the Pacific coast, reference was made to improvements which the Southern Pacific Company has under consideration for its suburban lines in Oakland, Berkeley and Alameda, to the rumored electrification of that company's San Jose and Port Costa lines and also to the possibility of operating its mountainous divisions by electricity. Mr. Doble concluded with some very interesting remarks on the leading hydroelectric power stations and transmission systems of California.

Rapid Transit Subways.

Mr. Lewis B. Stillwell, electrical director of the Interborough Rapid Transit Company, New York city, in speaking at the annual dinner of the American Institute of Electrical Engineers, drew some interesting conclusions as to the value of the present subway in New York city, and the features which should characterize future undertakings of a like nature.

As a public work the construction of the New York subway has been an object lesson of great significance and value. From start to finish it has been carried out under the direction of the Rapid Transit Commission, without fear or favor, and with an eye single to the public good. No money has been wasted and not the slightest scandal of any kind has attended its progress. The work is a splendid monument to the commission and to its engineers. The community has received maximum benefit at minimum cost. At the same time the enterprising men who ventured their capital in the enterprise, at a time when its success was generally considered doubtful, have reaped a handsome reward to which they are in every sense of the word entitled.

As a railway, the subway demonstrates the value of the four-track system with island platforms. This system makes it practically possible to double the speed which can be attained if two tracks are used. Doubling the speed means doubling the distance at which the average man may locate his residence with respect to his place of work, and, as has been pointed out frequently, doubling the distance means quadrupling the area within which men working in a certain business district can locate their homes and plant and cultivate their own individual vines and fig trees. Every north and south subway hereafter constructed on Manhattan Island should have four tracks—not less—and so far as practicable this rule should be applied in the case of tunnels running east and west, except perhaps those sections which are beneath the rivers. Two-track systems having three or four stations per mile can never secure rapid transit in the sense to which that term is properly limited in such a city as New York.

As regards equipment, the subway has demonstrated in the sight of all men the fact that trains weighing 320 tons can be driven by electric power at a speed of forty-five miles an hour between stations and that electric equipment can develop a tractive effort of 45,000 pounds, which is far more than double the draw-bar pull of the average passenger locomotive.

Electrification of the elevated lines in New York has increased their capacity by one-third and has decreased by one-fifth the time spent on trains by the average passenger. It has demonstrated that the cost of maintenance of electrical equipment of rolling stock is materially less than that of steam equipment. It has proved that electricity can render more reliable service than steam, the aggregate delays due to all causes on the Manhattan lines now being less than one-half per car-mile what they were when steam was used as a motive power. It has eliminated smoke, steam and cinders, formerly the cause of so much annoyance to abutting property owners and to people passing beneath the structure, and it has secured financial results eminently satisfactory to the stockholders of the Manhattan company. The combined system now controlled by the Interborough company is operating electrically more than 250,000 car-miles per day, which I believe is about four times the passenger car-mileage of the New York Central system.

ELECTRIC RAILWAY OPERATION IN A GREAT CITY.[1]

BY H. H. VREELAND.

I shall not take the time to describe in detail the extent of your opportunity in the business of transportation. That it is vast your observation will have told you. Substantially it is true, that wherever a line of railway in a town or city would be profitable by any means of propulsion, it would be especially profitable propelled by electricity, and your science has already reached that stage of development which shows that its employment in the movement of trains over long distances is close at hand.

Although it is true that all great industries are organized in this country to-day upon substantially the same lines, and while the peculiarities of each are apparently slight, it is in the comprehension of such differences as do exist that a specialist must excel. The distance between the claim agent and the electrical engineer seems remote until it appears that the engineer's device by its too great intricacy or delicacy of construction in the hands of a low-salaried motorman has involved the company into disastrous accidents. The distance between the electrical engineer and the auditor seems remote until when the engineer's device has been tested and compared, and its economic results have been written down in the auditor's cold figures and submitted to the general manager, the engineer is informed that it costs too much for instalment and saves too little in operation. It must not be supposed, therefore, that the utility of an idea or of the machine that embodies it has been fully passed upon even when the operating manager and the master mechanic are satisfied.

You are all familiar with the claim that the consolidation of great properties is against the interests of the individual, of labor as a class, of inventors as a class, of youth and ambition however employed, unless it is backed with money. It is constantly alleged, with most elaborate sophistries, that the ultimate result of consolidations is a reduction of working forces and that the effect of elaborate organization is to thwart ability and stifle hope. I suppose that, in a modified way, the experience of my corporation is that of every other. If it is, this is the fact—computing on a mileage basis, since the street railroads of New York city were consolidated into the Metropolitan system and since the electrical engineer drove the electrical force against the wheels of our cars, we employ three times the number of men that formerly were employed upon the same mileage. We have one president, it is true, instead of twenty odd, and we have reduced the number of secretaries, managers, treasurers and superintendents and the like, but as to the working force, from which the loudest protest is heard against combination, it is three times as great and its wages per individual have increased fifteen per cent.

Not only so, but in our organization we are absolutely dependent upon ability. What should an electrical engineer, who is a director's son but a man of no particular capacity, weigh with me against an electrical engineer through whose device I can start my cars more easily, stop them more swiftly, govern them more accurately, when my relation to my company depends solely upon the value of securities owned by ten thousand individuals scattered throughout the land? Influence may secure to youth an opportunity, it may set his foot in the right direction, but there never was a time when the length and the swiftness of his stride depended so entirely upon the man himself as they do to-day.

But combination has had this result and you must never omit it from your calculations. There is no one of the departments into which a great industry is now classified that is not going to be affected in its operation by each and every idea as to management that is attempted to be put into execution. The general manager, the secretary, the treasurer, the attorney, the chief engineer, the purchasing officer, expert and separate as each may be as to his particular functions, work so completely through the executive head of the industry that at that central point the effect of the slighest change at any spot in the whole working plane of operation is registered for the information of them all with the accuracy of the sensitive plate in the photographer's camera as it records the moving picture. Just when the change occurred and what its effect has been upon the entire prospect are witnessed for the judgment of all.

Important, therefore, as an electrical engineer or other expert is in the system of a street railway, his value depends upon his realization of the unity of the system and the effect which his idea, incorporated into an apparatus, is bound to have upon each department of a complicated organization. Of course he must bear in mind at all times that his machine must go into the hands of a class of men who, however expert they may become in its manipulation, must be recruited in large numbers from those whose physical strength is their chief capacity, there to be subject to continual use under the most disadvantageous conditions that can possibly arise. It must be stowed away where it is out of sight and reach, under the car body and close to the roadway. It must stand not only use, but the hardest sort of abuse, not only from the incompetency of a great army composed of unskilled labor, in which there will always exist a large percentage of gross dulness, and into which there must always be drawn another large percentage of inexperience, but from adverse weather conditions and from adverse conditions of traffic, and that the machine operating under these circumstances, however it may break down, must never be permitted to stand in the way of the car that is coming on.

These conditions, of course, are fairly obvious, but it is beyond belief how often some one or more of them has been overlooked by the electrical engineeer. He learns his business generally in some great establishment largely devoted to experiment where the gross earnings of an ordinary street railroad are written off the books in a single month of fruitless investigation, where he is provided not only amply, but even superfluously, with the tools of his trade, and it is difficult for him to understand when he comes to street railroad work that in the running of a car there is no time for repairs and that no device, however generally useful, can be employed on a street car which, if it falls out of gear, requires the car to be stabled before it can be repaired. He easily forgets that the motorman, however well instructed, is not a machinist; that he must keep his car going without the facility of a machine shop, and that often the most important repairs must be made at dead of night in a dark and narrow pit, with cheap labor and under whatever circumstances the fates may provide.

It is the characteristic weakness of an expert to exaggerate the importance of his line of work to the industry with which he is connected. No established industry can afford to spend more than a certain fixed proportion of its earnings upon improvements and betterments. It must pay its fixed charges, maintain its dividends and store up something in its surplus, and whatever it spends for betterments, whether by the use of what remains after all this has been done or by an issue of new securities, must be done with an eye carefully fixed upon its earn-

[1] Abstract of a lecture delivered recently before the New York Electrical Society, New York city.

ing capacity. The expert, whether an electrical engineer or other specialist, is rarely willing to concede this condition of things, and the more absorbed he is in his own line of investigation the more unwilling he becomes to admit that anything else counts. When, therefore, he ascertains that of the all too-insufficient sum that can be applied to improved methods some must go in one direction and some in another, and that the amount that is left for him to work on is but a fraction of the insufficient whole, his dismay not infrequently takes the form of a fit. He has been trained, moreover, in institutions where experiment is a part of the business, and when he goes into the service of an established industry or undertakes work for the advantage of such an industry, he is slow to adjust himself to the fact that it has no funds for experiment. No small part of the discouragement which awaits the specialist as soon as he leaves that occupation in which his specialty is the sole aim and business to employ his talents and training for the benefit of an industry in which his specialty is merely a feature, arises out of this circumstance, and he must quickly learn the great art of making bricks without straw. He will find his consolation in the fact that that is the only way good bricks are ever made; that the man who can only produce when the conditions of production are perfect rarely produces anything worth while; and that the valuable things of life almost invariably come by easy and natural stages from one good and successful thing to another that is better and more successful, from one valuable improvement to another that is better still, and that the perfect has never been reached but is always further on. His opportunity is limited, therefore, not by what has been accomplished, but only by the inevitably insufficient means with which he must work. He has accomplished his greatest triumph when he has adjusted himself to this fact.

So swift has been the advancement in your science that there always exists the great practical danger of your getting too far ahead, commercially speaking, of the operator. If I were to write to a manufacturer of a locomotive and say that I wanted ten of his machines and wanted them to attain a certain standard and be able to perform a certain work, and when I had them a couple of months in operation and, having ascertained that they were not perfectly adapted to my other stock, upon complaint to the manufacturer were to be told, "that locomotive is two months old; what you want is our new locomotive; you must throw all those two-months-old locomotives away and buy our new and perfect machine," I should feel that I was being pretty badly imposed upon. This, however, is a common experience in dealing with electrical engineers and manufacturers of electrical apparatus.

It is no unusual experience for us to buy and install a very expensive electrical device, to discover that it does not work in perfect synchronism with other parts of the machine or with other machinery necessary to be operated with it and to have it said to us, "nothing ails this new motor; it is a good motor. What you want is a new governor; since we made that motor we have made some other new things to go along with it; you must get that." And then before his other new thing has been in operation a week still another and still a better thing has been devised or is claimed to be devised. There is great danger of your getting too far ahead of us. This may be all very well for the development of the science, but in a practical sense it is not well for you or for us. If you are going to make money at your profession, you must help us make money in our business. You must not forever be postponing the day when income begins to pay for investment. You must not be forever requiring one great investment on top of another until we have paid half a dozen times over for substantially the same service. You must keep the practical phase of every subject closely harmonious with experimental conditions.

If I can do you any service, it will be by leaving with you the idea that the world does not want to be pushed or jarred or thrown out of gear; it wants to be facilitated in the daily routine to which it has grown accustomed. It resents a shock; it is pleased with an accommodation; it pays for what it wants. It leaves the giver of what it does not want, though his benefaction be ever so great, to the unsatisfying reward of private reflection.

British Royal Commission on Coal Supplies.

The final report of the British Royal Commission on Coal Supplies has been made. The report is of a reassuring character, as it indicates that the available coal supply is considerably more than had been anticipated. Adopting 4,000 feet as the limit of practical depth in working, and one foot as the minimum working thickness, the commissioners estimate the available quantity of coal in the proved coal fields of the United Kingdom to be 100,914,668,167 tons. The estimate of the coal commission of 1871 was 90,207,-285,398 tons, and since that year 5,694,-928,507 tons have been raised. The estimate for the concealed and unproved coal fields is approximately 40,483,000,000.

No forecast is made of the time when the coal fields will be exhausted. It is believed by the commission that the use of artificial briquettes will increase, and in this way coal at present valueless will be made use of. The discovery of a less costly and less smoky binding material for use in briquette-making would be of great value.

The coal consumption for 1903 is estimated at 167,000,000 tons. Of this it is said that from 40,000,000 to 60,000,000 tons might be saved if more economical methods of raising steam were adopted.

Convention of the Kansas Independent Telephone Association.

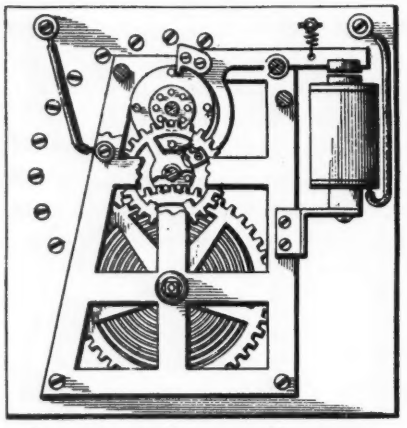
The fourth annual convention of the Kansas Independent Telephone Association was held at the Hotel Throop, Topeka, Kan., February 8 and 9. The address of welcome was made by Governor Hoch, followed by an address by A. A. Goddard, president of the association. The Thursday session was devoted mainly to the reading and discussion of papers, followed by the election of officers, as follows: president, A. A. Goddard, Topeka; vice-president, J. M. Doyle, Belleville; secretary, E. C. Walls, Marion. Executive committee: J. E. Byers, Ottawa; M. L. Robinson, Galena; C. E. Pearl, Hiawatha; W. H. Nedson, Smith Center.

The Iowa Telephone Association.

The ninth annual meeting of the Iowa Telephone Association will be held at the Chamberlain Hotel, Des Moines, Iowa, March 14, 15 and 16. The sessions of the association will be held in one of the private dining-rooms on the parlor floor. Telephone manufacturers and supply men will make exhibits on the fourth floor of the hotel. A full programme is being prepared, and it is expected that the occasion will be a most enjoyable one. The association's banquet will be held on Wednesday evening, March 15. Mr. Charles C. Deering, Boone, Iowa, is secretary of the Iowa Telephone Association.

Electrical Patents.

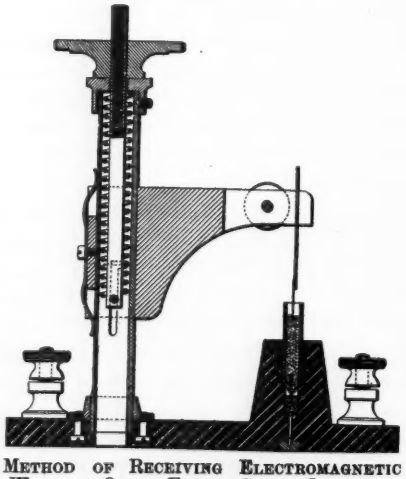
James C. Slater, of St. Louis, Mo., is the inventor of a novel stopping and releasing mechanism, on which he has recently obtained a patent (No. 780,824, dated January 24, 1905). The mechanism comprises a wheel and a lever cooperating therewith to permit the step-by-step advance of the wheel under the impulse of operating mechanism of



Stopping and Releasing Mechanism.

suitable character. The device, while applicable for use in any relation requiring uniform intermittent movement of a rotary element, is designed with special reference to its use as the controlling means of a selector-switch constituting an element of an automatic telephone system—such, for instance, as that described in letters-patent No. 632,759, issued to Mr. Slater on September 12, 1899. In systems of this character the telephones are each provided with an indicating apparatus suitably wired to a selector-switch having a series of contact-points corresponding to the several subscribers' telephones. Each selector-switch is arranged for actuation by an electromechanical switch-operating mechanism, which moves the switch-arm into engagement with any desired contact. The operating mechanism of the selector-switch is controlled by stopping and releasing mechanism operated by electromagnetic means including a circuit-breaker associated with the indicating apparatus of a telephone. The greatest difficulty which has heretofore been experienced in the perfection of an automatic system has been to secure the proper action of the selector-switch controlling mechanism so as to maintain perfect synchronism, the usual forms of such mechanism being more or less liable to race or lock or to reverse under various conditions. The object of the present invention therefore is to produce a device which will be peculiarly adapted for the control of a selector-switch and which, by reason of the novel construction and arrangement of its parts, will be absolutely incapable of racing, locking or reversing, thereby ensuring that perfect synchronism in all its parts so essential to ensure correctness of the call desired. The device comprises a wheel having a smooth periphery and a series of lateral projections. A lever is provided having at one end an accurate arm connected at its upper extremity to the end of the lever and movable into engagement with the periphery of the wheel to constitute a brake therefor. Opposed pallets are located at opposite ends of the accurate arm and alternately presentable in the path of the projections to stop the wheel by the movement of the lever in opposite directions. Means are employed for moving the wheel when released by the lever.

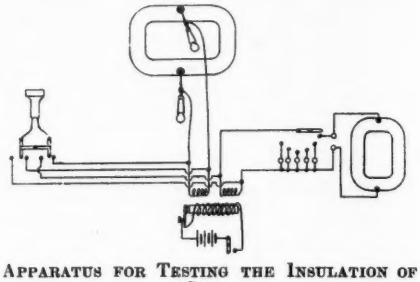
The Wireless Telegraph Exploitation Company, of New York, N. Y., is the owner of a patent recently granted to Frederick K. Vreeland, of Montclair, N. J., on a method of receiving electromagnetic waves or other feeble signal impulses (No. 780,842, dated January 24, 1905). The invention is especially useful for the reception of signals in wireless telegraphy, and depends upon the discovery made by Mr. Vreeland that an electrolytic cell of a special character, when polarized to the



Method of Receiving Electromagnetic Waves or Other Feeble Signal Impulses.

proper critical point by a local battery, is extremely sensitive to transitory or rapidly oscillating currents from another source, which when passed through it tend to depolarize the cell and cause it to offer less opposition to the passage of the local current, which rises and falls in value with the presence and absence of the transitory waves or impulses and affords an effective means for operating a telephone or other signal receiver. The method consists in polarizing an electrolytic cell having a minute anode by means of a local source of electromotive force producing at the cell a voltage above the decomposition voltage of the cell but below the point where a violent evolution of gas is caused, passing the waves or impulses to be detected through said cell and thereby wholly or partially depolarizing the cell, whereby the current in the local circuit will be increased, and observing the variations in flow of the local current.

A novel apparatus for testing the insulation of coils has been recently patented by Edmund W. Kellogg, of Newtonville, Mass. (No. 780,507, dated January

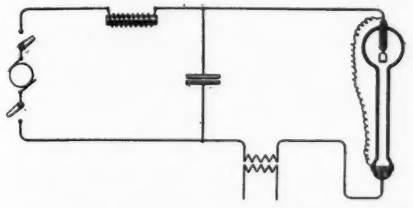


Apparatus for Testing the Insulation of Coils.

24, 1905). The object of the invention is to provide a simple, efficient and inexpensive apparatus of the above character. In accordance with the invention, two independent circuits are employed, each of which includes the secondary winding of an induction coil, and connected with one of these circuits is an insulated coil of known or standard resistance, and with the other an insulated coil whose insulation is to be tested. The primary winding of the induction coil is included in a circuit provided with means for creating an induced current in the secondary winding, which current operates a telephone included in the second circuits, whereby the sound produced in the secondary circuit containing the unknown resistance may be compared with the sound produced in the secondary circuit containing the standard or known resistance and defects in the insulation of the tested coil noted by the difference in sound at the telephone.

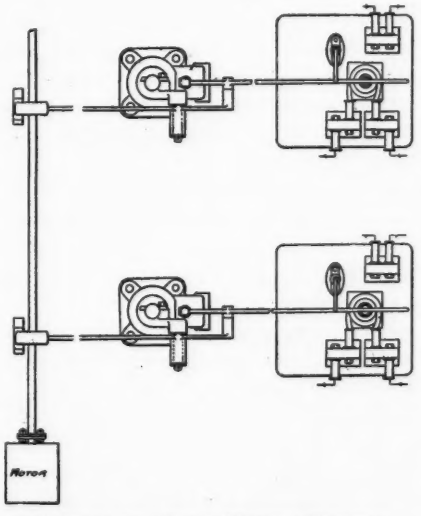
Mr. Peter Cooper Hewitt has secured a patent (781,000, dated January 31) on an apparatus for transforming electrical energy, which he has assigned, by mesne assignment, to the Cooper Hewitt Electric Company, of New York. Mr. Hewitt has found that when an enclosed gas or vapor of suitable character and density contained within a holder of suitable character and dimensions and having appropriate electrodes is connected in an electric circuit, there will be opposed to the passage of electric current an initial re-

sistance, which may be overcome by an electromotive force of sufficient value, the gas or vapor then serving as a conductor across the gap in the metallic circuit when the proper conditions of current are supplied. This initial resistance appears as a self-created electrical resistance phenomenon at the negative electrode, which, on being overcome, removes itself without any appreciable energy loss. A feature of the invention is that the gas between the electrodes acts as a true vapor conductor after the circuit is once established through the vapor, and when this conductor is made of low resistance practically a short-circuit is formed. Since the vapor resistance factors are known and the conditions they are subject to, the action can always be depended on. By the passage of current, the electrical pressure or voltage is lowered to a point where the resistance to starting reforms, whereupon the checked current rebuilds or reestablishes itself, its electrical pressure rising until the breaking down pressure is again attained, after which the same succession of actions is repeated. The intermittent or vibratory currents produced in the circuit by the circuit-breaker thus described, may be applied to use in the vapor or gas gap itself, or they may be applied to other apparatus, or to both simultaneously. For example, one application of the present invention would be to serve the purposes of furnishing a periodic current for wireless telegraphy and another for producing rapidly varying currents for the purpose of producing light by induction, and still another application would be that of producing light—say in the vapor gap itself—by means of successive electrical impulses of relatively high electromotive force, causing a high illumination of the vapor or gas at such rapid intervals that the physiological impression is that of continuous illumination.



APPARATUS FOR TRANSFORMING ELECTRICAL ENERGY.

A patent (781,154, dated January 31) has been obtained in this country by Charles A. Parsons, of Newcastle-Upon-Tyne, and James Swinburne, of London, England, Mr. Swinburne being the assignor to Mr. Parsons, on a method of controlling the running of reciprocating engines or turbines driving alternators in parallel. The object of the invention is to provide an arrangement which renders it possible to drive alternators in parallel either by two or more turbines alone or in conjunction with reciprocating engines, so as to reduce the interchange currents to a minimum. To carry this into effect, puffing-valves, of known construction, are used for the control of the turbines, the puffing-valves being operated from a suitably driven shaft in such a way that they open and close simultaneously, while the regulation of the amount of steam passed by each valve is also effected simultaneously, but by means independent of those used for securing the simultaneity of the puffs. If a reciprocating engine is used in conjunction with the turbines, then the shaft which drives the puffing-valves must be driven from a part of the reciprocating engine in such a way that the maximum turning moments of the turbines and the reciprocating engine fall together. If a plurality of reciprocating engines is used, they must be arranged among themselves in the manner described above and the shaft which drives the puffing-valves must be driven from a suitable part of some one of them.



CONTROL FOR PRIME MOVERS DRIVING ALTERNATORS IN PARALLEL.

An incandescent lamp, having straight filaments and comprising certain improvements for taking up the slack of the filament as it expands or contracts during heating or cooling, is the subject matter of a patent (781,016, dated January 31) recently granted to Almon D. Page, of Newark, N. J. The patent has been assigned to the General Electric Company, Schenectady, N. Y. In the embodiment of the invention, the exhausted envelope of the lamp consists of a straight glass tube. In this tube is located a straight filament of any suitable material, which is electrically connected to leading-in conductors, located, respectively, at opposite ends of the tube. The upper end of the filament is connected directly to one of the leading-in conductors, while the lower end of the filament is electrically connected, through a flexible coiled conductor, to the lower leading-in conductor. The respective leading-in conductors are connected to suitable terminals on the outside of the lamp. The lamp is intended to be used in a vertical position, and Mr. Page has taken advantage of this fact to maintain the filament taut by securing to the lower end thereof a weight which may consist of a glass ball. This ball is located within a small tube, the walls of which constitute a guide for the ball or weight, and prevent the latter from being displaced. The upper end of the tube is closed in, so as to confine the ball, but this turning in is only partial, so that an opening is left for the passage of the lower end of the filament.

INCANDESCENT LAMP.

Electric Trucks in Cologne, Germany.

A number of electric trucks have been put into service in Cologne, Germany, says *L'Industrie Electrique*, replacing horse-drawn vehicles. These trucks have a capacity of ten cubic metres, as compared with two cubic metres for the horse vehicles. Experience has shown that an electric truck can serve an area of 600,000 square metres per day, while five horse-drawn vehicles are required to do the same work. The daily expense is said to be $5 per electric truck, as compared with $2.50 for each horse-truck. Thus, the electric truck brings about a daily saving of $7.50. One advantage of the electric trucks is that they can be attached to the rear of electric cars.

Reviews of Current Engineering and Scientific Literature.

A Detector for Hertzian Waves.

A new and simple detector for Hertzian waves is described here by M. Joseph Rodet. It consists merely of a glass tube of suitable size to contain a series of steel bicycle balls. The tube is closed at each end by a brass collar. Through one of these collars projects a brass screw, used for adjusting the pressure on the balls. The alternate balls are oxidized. The device is used in circuit with a telephone and two Leclanche batteries. When employed in this way, M. Rodet has found it quite sensitive and reliable. Its sensibility is not affected by severe shocks, and when once adjusted, it remains adjusted for a considerable time. The inventor thinks that the device is very suitable for use on shipboard, as there is no need to protect it from jars or vibration.—*Translated and abstracted from L'Électricien (Paris), February* 4.

The Bouvier Speed Governor.

A water-wheel governor, designed by M. Henri Bouvier, and used in a French hydroelectric station, is here described. The governor consists of a pump driven at a constant speed, and a valve controlled by a flyball governor. This valve, by allowing more or less of the liquid delivered by the pump to pass into a piping system, controls the pressure within that system. The varying pressure thus produced is used to operate the turbine gates and adjust the flow of water through the turbine. The adjusting device consists of an hydraulic cylinder, within which a piston is moved by the liquid forced through the pipes against a spring. The position of this piston is then fixed by the spring for any fluid pressure in the piping system, and thus the position of the gates is similarly fixed. The action of the governor is as follows: assuming the turbine to be running at any load, and the latter to be increased, the centrifugal governor responds to the change in speed, moves the controlling valve, and changes the pressure within the pipes. This opens or closes the gates, as may be required, the motion continuing until the pressure of the liquid is just balanced by that of the spring. It then stops, and there is no hunting or surging of the governor. It was to avoid this latter trouble that the new governor was devised. It has been in operation for some time, and has given excellent results. The article shows a load and speed chart giving an increase in load from 0 to 1,200 horsepower with a change in speed of about six per cent. Throwing off about half the load caused the speed of the turbine to be increased about two per cent. The curves show no oscillation whatever of the governor. It merely follows the change in load, and becomes steady as soon as the load is steady.—*Translated and abstracted from La Revue Pratique de l'Electricité (Paris), January* 20.

The Efficiency of Electric Hauling Gears.

Accurate figures for the efficiency of spur gearing are not easily obtainable, and there has been a great deal of doubt as to the efficiency which may be secured. In this article Mr. A. G. Hansard describes some interesting tests made to determine the efficiency of an electrically driven haulage gear, in which the reduction of speed is obtained through spur gears. The specifications called for a gear giving a tension on the rope of 5,000 pounds, with a speed of 330 feet per minute, and the speed was to be approximately constant at other loads. It was further requested that a guarantee of efficiency be given in the tender. This latter requirement some of the firms which were asked to bid refused to comply with, others offered to guarantee efficiencies varying from sixty-four to seventy-eight and one-half per cent at three-quarters load. The order was finally placed with the Sandycroft Foundry Company, Limited, Chester, England. The gear is formed of two drums, provided with clutches so that either may be driven independently. They are equipped with hand brakes and a magnetically released strap brake. The reduction in speed is from 600 revolutions at the motor shaft to 24.6 revolutions at the drum, the ratios being sixteen to eighty-three and seventeen to eighty. To determine the efficiencies, the working brakes were replaced by a pair of Prony brakes, and tests made. A number of readings were made at three-quarters load, all being fairly close together. In these it was found that the overall efficiency is eighty-five per cent at three-quarters load, which seems very high. The figures for full load and half-load were 84.6 and 83.1, respectively. The efficiency of the motor had been determined separately by the Hopkinson test, and was found to be 90.5 per cent, which would indicate an efficiency of the gearing itself of over ninety-two per cent. This result was obtained by careful design and accurate working of the gears.—*Abstracted from the Electrician (London), February* 3.

Long-Distance Transmission of Energy.

A study of the problem of line construction for long-distance electrical transmission of energy has been made by Signor Guido Semenza. He holds that this is a mechanical problem pure and simple, the object being to suspend a certain number of wires in a determined way with the least expense for upkeep and first cost, and at the same time obtain a reliable system. The wires should be arranged geometrically at distances determined by electromagnetic laws. Although there are many possible arrangements, the most desirable is held to be one in which the wires are placed at the angles of an equilateral triangle, with one side of the triangle vertical. This arrangement gives the longest allowable span. The support must combine certain mechanical properties with high electrical resistance. As the supports may be placed different distances apart, it is necessary to determine that most advantageous. This is done by treating the problem as has been done in determining the best designs of bridges and other similar structures. In selecting the route to be followed, it should be borne in mind that, although a straight line may be less expensive to erect, since the distance is shorter, and special poles are not needed, the cost of right of way over such a route may make the total cost of such a line greater. Signor Semenza thinks that the effect of the wind pressure has been exaggerated. He points out that the shape of the wire reduces the effective surface, and thinks that an allowance of 100 kilogrammes per square metre of section would be ample. At present 200 or 300 kilogrammes are more often allowed. Long spans with few poles are, in general, advantageous, and these can be used with deep sag. The advantages of iron towers, which are rigid at right angles to the line, but flexible in the direction of the line, are pointed out. In case of a break in the line, such towers will bend and transmit part of the strain to the neighboring towers. A comparison is made between two designs of a line, one using wooden

poles placed thirty-five to the kilometre, and the other iron towers placed nine to the kilometre. The expense of the wooden poles is found to be $245 per kilometre; $168 for 210 insulators; $40 for erection; $120 for right of way, and $56 for cross-overs, making a total of $629. For the tower construction, the cost of the towers per kilometre is $360; the cost of erecting them, $90; for insulators, $64.80; for erection, $40; for right of way, $120, a total of $674.80. Thus, the expense of erecting the two lines differs but little, but it is thought that the tower construction will be much less expensive to maintain. A life of twenty-five years is thought to be allowable, while for the wooden pole line it would be only five or, at the most, ten years.—*Translated and abstracted from the Revue de L'Électricité (Lausanne), January* 31.

Insulation of Armature or Other Coils of High-Tension Apparatus.

After some unfortunate experience in having the insulation of high-potential, alternator-armature coils break down, Mr. J. S. Highfield made a careful investigation of this trouble. The particular machine examined was wound for 10,000 volts. The copper is insulated from the core plates by means of solid mica or micanite tubes having a dielectric strength capable of resisting at least four times the working pressure. The ends of the tubes in this particular case are carried out quite clear of the frame, leaving no chance for sparking to take place at the ends. The insulation between the coils is varnished cotton braiding. The coils themselves are formed of ribbons wound through two tubes. Upon examining a coil and splitting open the tube, it was found that serious corrosion had taken place, the braiding being practically destroyed and the copper covered with a green deposit. Upon inspecting the ends where they were wrapped with cloth, it was found that the tube was completely rotted, being quite damp and having a strong acid reaction. The braiding at this point was in fairly good order, but damp and showing an acid reaction. Analysis of the green deposit on the copper proved it to be nitrate of copper. There also appeared to be a certain amount of free nitric acid present. In the empire cloth at the ends of the coils, sulphuric acid was found. As all the materials were of the best, it was suspected that the nitric acid had been formed by a brush discharge which caused ozonization of the air. To make sure of this fact, one of the tubes was cleaned carefully, and a strip of bright copper gauze, covered with pure filter paper, was placed inside the tube. The outside of the tube was covered with tinfoil, and connected to earth. The copper was connected to a supply of 10,000 volts. The paper was not specially dried. Ozone was observed at once in considerable quantities, and in about one week a considerable amount of green deposit of nitrate of copper was formed on the copper gauze, and free nitric acid on the filter paper. This explains the breakdown of the alternator mentioned above. The nitric acid was due to the action of ozone upon atmospheric nitrogen, and the sulphuric acid was due to the action of the nitric acid upon the gypsum contained in the board wrapped around the ends. The conclusion is drawn, that for any machine operating at a pressure of 2,000 volts or over, trouble from this cause may be experienced. While careful drying would delay the trouble, the only means of preventing it would be to exclude completely all moisture. This can only be done by excluding air from the coils. The proper method of doing this would be to fill the entire space, from copper to iron, with insulating material. The mere sealing of the ends of the tubes is not likely to be a remedy, as cracks will develop and moisture will be drawn in as the air alternately expands and contracts. The insulation of the last two or three coils at the end of the armature should be most carefully looked after, as the danger is greatest at these points.—*Abstracted from the Electrician (London), January* 27.

The Future of Railways.

A careful study of the situation confronting the railways of England is here begun by Mr. Philip Dawson. Statistics show that, while the mileage of steam railways and the capital invested in them have increased very greatly during the last thirty years, the percentage of net receipts to total paid-up capital has steadily decreased, and the percentage of working expenses to gross receipts has, on the contrary, steadily increased. There seems to be no reason to doubt that the rapid increase of electric tramways in the large towns and populated districts will affect the steam roads still more, and this will be all the greater when the electric roads undertake other business besides that of hauling passengers. Considering the future of the steam railroads, it should be borne in mind that the services which railway companies render to the public are varied, and a universal system of electric traction can not, as far as present knowledge extends, be looked for in the near future. There is no doubt that, as regards the engineering of the purely mechanical portion of the problem, electric traction could be at once adopted as a substitute for steam haulage; but this is not the problem to be solved, nor is it the one which is having the serious consideration of practical engineers. Unless it can be clearly demonstrated beyond all doubt that the new system will enable larger dividends than at present to be paid on capital invested, there is no justification for recommending its adoption. For purposes of the article, the work of railway companies is subdivided into four classes: first, long-distance main line service, which may be characterized as service with runs of fifty or more miles without stopping, and connecting such places as London and Brighton and London and Liverpool; second, freight traffic involving the use of long and heavy trains having to haul considerable distances at a comparatively slow rate of speed; third, suburban passenger service, connecting the suburbs of the large cities with centres of business; fourth, local or branch lines, connecting the small country towns with the big business centres, or connecting towns on the through main lines to offlying market centres. As regards the long-distance main line service and the freight traffic, it is held that there is no advantage to be gained by superseding steam locomotives. In the case of countries having large water powers which can be utilized at not too great a cost for driving electrical machinery, or where coal is very expensive, the case might be different. Considering the last two categories, the case is different, and there appears to be little doubt that, by using improved methods of locomotion and methods of haulage for suburban and for branch lines, not only could working expenses be considerably reduced, but also the gross receipts could be considerably increased. As regards suburban traffic, it seems that electric traction is the only means of dealing with it; whereas, with branch line service, it appears more probable that motor-cars, driven by some motive power other than steam, may be applied with very beneficial results. The author then considers in detail the general traffic conditions of suburban services. It is held that, as soon as the railways electrify their suburban lines, they will hold a very strong position against the attacks of competing tramways and light railways, since they will have all the advantages of the latter, without the disadvantages of having to operate through crowded thoroughfares. They will be able to operate at higher schedule speeds, as stops are further apart. It is practically impossible to give the requisite high speed by any other than electric traction.—*Abstracted from the Electrical Review (London), February* 3.

LETTERS TO THE EDITOR.

London, Brighton & South Coast Railway.

To the Editor of the Electrical Review:

In your issue of February 11, 1905, I notice, under the heading of "The Electrification of an Important English Railway," that the London, Brighton & South Coast Railway has adopted a class of return which I have been advocating for the last ten years; and it can not be considered a breach of professional etiquette if I now give an extract from a private report which I submitted in January, 1903, to one well-known consulting engineer.

"With a surface system of traction using a bare overhead conductor and track rails for its grounded transmission medium, it appears as if the best method would be to not bond the rails. Instead of such bonding, insulated cables could be run between the tracks or in ducts to which all the rails could be connected by means of insulated bond wires. With the generating medium of such a system insulated, such a plan would fairly securely confine the energy used to these insulated cables. Such cables and bonding are at present used on well-designed trolley roads with this exception: that they are bare instead of being insulated."

I may also say that I suggested similar installation to several members of the Liverpool town council in 1896-97.

J. Stanley Richmond.

New York, February 14.

Application of Wireless Telegraphy for Domestic Purposes.

To the Editor of the Electrical Review:

Noting a reference to an adaptation of wireless telegraphy to the operation of music boxes for entertaining purposes, mentioned in the Electrical Review of January 28, 1905, it occurs to me to call your attention to an application of wireless telegraphy to domestic purposes which may be of interest to your readers; as I believe it to be not only novel, but susceptible of extensive employment and with advantage in our homes.

During the year 1904 and the present year as well I have used upon my dining-room table a tiny transmitter consisting of an induction coil with antenna, spark-gap and key, connected by means of a flexible silk cord with four small dry batteries under the table, these being used for sending Hertzian waves through the walls to the kitchen for summoning the maid. In the kitchen mounted upon a board was a second antenna, coherer, relay, electric bell (the tapper of which was used as a decoherer) and about eight small dry batteries. This outfit served to do away with the usual floor push-button which often wears holes in the floor carpet or rug and which button is so hard to locate especially if the table has been lengthened or moved and moreover necessitates making holes in floors and walls for running wires to the bell and batteries in the distant room, it also entails considerable expense, annoyance and dirt. The transmitter used is but little larger than a good sized paper-weight and is rather ornamental than otherwise. I arranged the antennæ in spiral form at the bottom so that by pulling them out and lengthening them I could use the transmitter under the same conditions from any room in the house, by the sick bed, for instance, for summoning the nurse or the maid.

I recently had the pleasure of entertaining at dinner at my home my friends Dr. Lee De Forrest, of wireless telegraphy fame, and Mr. A. B. Frenzel, commissioner of rare minerals for the state of Colorado at the St. Louis Exposition, and they were much interested in the use of "wireless" at my table on that occasion, and Dr. De Forrest said he believed this to be the first application of the system to domestic needs. I might also state that nearly five years ago I used a somewhat similar outfit to ring my front door bell and fire a small cannon in my parlor while entertaining a party of friends at my home. On this occasion I carried the transmitter under my arm to the rear of the building while operating same. The wireless outfit which I employ might with advantage be modified for domestic use. It was built for me by Mr. W. J. Clarke, of the United States Electrical Company, of Mt. Vernon, N. Y., who has done some very early and interesting work in this field.

Yours very truly,

William J. Hammer.

New York, February 7.

Electrical Equipment of the Suburban Lines of the Great Western Railway, England.

The progress which has been made with the electrical equipment of the Bishop's Road-Hammersmith section of the Great Western Railway, of England, is described in the London *Electrician* for February 3. This section is run in connection with the inner circle of the Metropolitan and Metropolitan District Railway companies. The decision of the Great Western Railway Company to adopt electric operation was influenced by the arbitration proceedings as to the method of electric traction to be put into operation upon the inner circle. The total length of the first section to be equipped is 3.69 miles of double track, standard gauge. The track rails weigh 97.5 pounds to the yard. The steepest grade is one in fifty, and the sharpest curve has a radius of 400 feet. An insulated third-rail and fourth-rail system has been adopted, in order that there may be intercommunication between this line and the inner circle. The conductor rails are inverted channel rails of ten square inches section, having a guaranteed average conductivity of 15.5 per cent of that of pure copper.

The power for this line will be generated at Park Royal, three and one-half miles distant from the line. The plant will consist of ten Babcock & Wilcox boilers fitted with stokers and superheaters. There will be eight 750-kilowatt generating sets. The generators are driven by 1,250-horse-power Belliss engines, and are three-phase, fifty-cycle, 6,600-volt machines. Current will be supplied from the generating station through three-core, paper-insulated, lead-sheathed and armored cables, laid in asphalt-lined steel troughing, to two substations, where it will be converted to 600 volts, continuous current, by means of Bruce-Peebles-Lacour motor-generators, in parallel with storage batteries. The trains will be made up of two motor-cars and four trailer-cars, the whole train seating from 304 to 320 passengers. There will be four motors on each car, controlled on the multiple unit system. The average speed, including stops, will be sixteen miles per hour, and the maximum speed, thirty miles per hour.

Electrical Manufactures in England.

The *British Trade Review* (London) for February 1, in an article discussing the trade conditions in Lancashire, says that the work at the electrical factories has improved very materially, and that the British Westinghouse Company, Mather & Platt, and Dick, Kerr & Company and several other concerns have plenty of work. The power companies are also finding more customers and supply power to mills, factories, mines and other undertakings. Both mechanical and electrical engineers are becoming important factors in lighting, hauling and coal-cutting in mines, and coal-cutting machinery is now extensively employed in the collieries.

INDUSTRIAL SECTION.

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS.

An Improved Direct-Connected Variable-Speed Motor Drive for Planers.

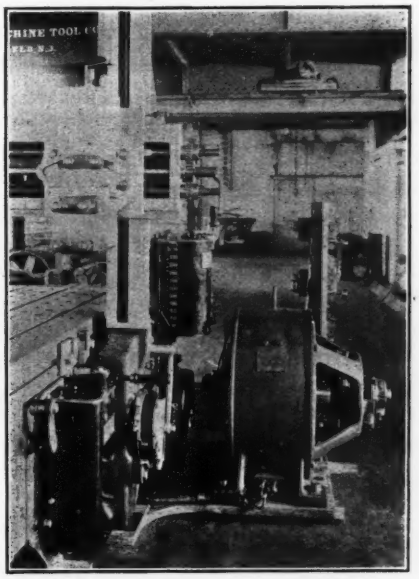
The Electric Controller and Supply Company, of Cleveland, Ohio, holds the patents for a direct-connected, variable-speed motor drive for planers, which it has recently placed on the market. The illustration shows the drive attached to a 36-inch by 36-inch by 12-foot Pond planer, which was exhibited at the St. Louis World's Fair. The company was awarded a gold medal for the drive.

When the modern high-power tool steels were put upon the market it soon became evident that all classes of machine tools must be made heavier and stronger if advantage was to be taken of the heavier cuts at faster speed thus made possible.

The lathe was the first tool taken up by most builders and by means of combinations of back gears a great range of speeds was obtained. There are, however, many jobs such as the facing of piston heads, flange couplings, etc., where a given number of revolutions per minute gives a high cutting speed at the periphery but an exceedingly slow cutting speed when nearing the centre, making it desirable to be able to change speed at will without stopping the lathe, as this invariably leaves a mark on the work. Another and more important reason for wishing to change speed without stopping is that no operator can judge accurately just what cutting speed the tool will stand before starting, so it is desirable to be able to start slowly and increase to the maximum that tool and machine will stand.

The individual direct motor drive with a controller giving speed variation by means of field and armature resistance was applied with greater success than any of the various mechanical devices. This drive was simplified and perfected by the development of the variable-speed motor giving the whole range of speeds necessary, with full rated horse-power throughout, without the use of any change gears. It has been used with perfect success for the lathe, boring mill, drill press, milling machine and small shaper, but with less success for planers and large shapers, for here it is necessary to provide for reversal.

There are a number of belt drives built using motors and mechanical change speed clutch devices, intermediate speed variations being obtained by motor control. A heavy pulley or flywheel is used to furnish the extra power required at reversal. The motor is usually mounted on top of the housing which necessitates the belts running vertically, and therefore very tight. The slippage, inevitable with heavy work at high speeds, and the constant reversals are ruinous to belts, so that it is not possible to take full advantage of the cuts and speeds which the modern tool steels will stand. Constant-speed motors with mechanical, hydraulic



ELECTRIC DRIVE AND CONTROL FOR PLANER.

or magnetic friction clutches for reversing, and change gears for varying the cutting speed have been used with some success, especially for the smaller sizes. At best, however, these devices give but a few set speeds, and as the clutch can transmit its full rated power only at the speed for which it was designed, no variation by means of motor control is possible. It requires some time to change the gears and then perhaps the operator must use the lowest speed because the tool will not quite stand the next step.

It is evident that to get maximum output from a planer, as from other tools, we must have a wide range of cutting speeds in small steps from the lowest to the highest. This has been accomplished by gearing a variable-speed motor direct to the driving shaft, and by means of a reversing switch, operated by dogs adjustably mounted on the platen of the planer, working in conjunction with a set of stopping and accelerating switches, the motion of the motor is reversed at either end of the stroke. The operation of the controller is such that the driving motor will reverse and accelerate the platen of the planer just as rapidly as is consistent with the power of the motor. The maximum current which can flow to the motor is absolutely limited, so that there is no sparking or undue mechanical straining at the instant of reversal.

The speed controller is provided with a marked dial showing the cutting speed. To obtain the desired speed it is simply necessary to turn the handle to the proper notch, and this speed can be changed at will without stopping the planer. A similar speed controller for the return stroke is provided if desired. Cut and return stroke speeds are entirely independent.

The platen may be reversed by hand for setting up work and for adjusting the dogs for proper length of stroke. A shifter lever attached to the reversing switch is used for this purpose and the operator can stop the planer instantly by putting it in the central position. This shifter motion is carried to the far side of the table as is usual for belted planers, so that any machinist accustomed to operating a belted planer can operate a planer equipped with this drive without further instruction. The accelerating controller is automatic and requires no attention whatever from the operator.

The illustration shows the motor geared to the cross shaft, accelerating board just beyond the motor, small speed controller on the housing convenient to the operator and reversing switch with its shifter handle actuated by the dogs on the platen.

Variations of cutting speed through a range of two and one-half to one are obtained with single voltage direct current, and of five to one with two voltages direct current, with corresponding ratios for the various multivoltage systems.

The drive can be applied to any planer, old or new, does away with all belts or clutches and will undoubtedly make possible increased output of from 50 to 200 per cent over the regular belt-driven planer.

Cutler-Hammer "Compound" Starting and Regulating Rheostats.

The Cutler-Hammer Manufacturing Company, Milwaukee, Wis., has brought out a line of starting and regulating rheostats which are shown in the accompanying illustrations. Figs. 1 and 2 show a starter which has an underload release only, in the "off" and operative position, and Figs. 3 and 4 show a starter with both underload and overload release, in the "off" and operative position.

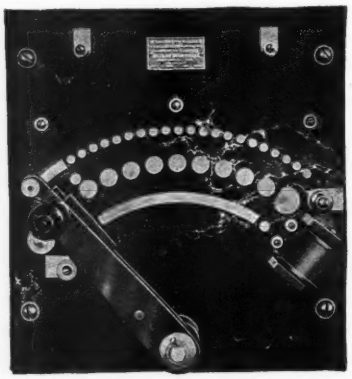


FIG. 1.—STARTING AND REGULATING RHEOSTAT, WITH UNDERLOAD RELEASE—"OFF" POSITION.

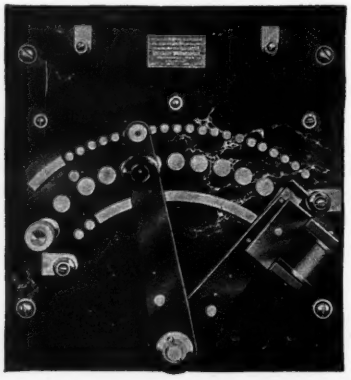


FIG. 2.—STARTING AND REGULATING RHEOSTAT, WITH UNDERLOAD RELEASE—OPERATIVE POSITION.

This type of controller is intended for the operation of machine tools or similar apparatus, in which the operator is within reach of the controlling handle, the speed regulation being effected entirely by means of shunt-field control. The objects sought in design were the provision of a large number of field regulating points, the elimination of possibility of the motor starting on weakened field, the operation of the device with a single lever in a simple and natural manner, and the returning of all parts to the starting position automatically under conditions necessitating this action.

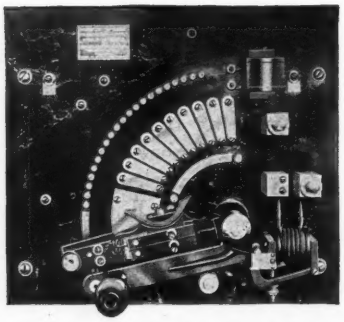


FIG. 3.—STARTING AND REGULATING RHEOSTAT, WITH OVERLOAD AND UNDERLOAD RELEASE—"OFF" POSITION.

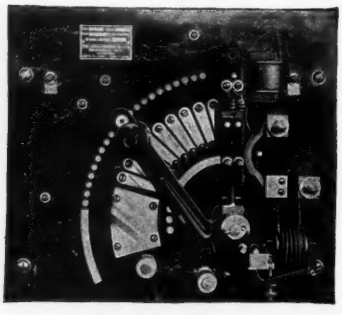


FIG. 4.—STARTING AND REGULATING RHEOSTAT, WITH OVERLOAD AND UNDERLOAD RELEASE—OPERATIVE POSITION.

The apparatus consists of a motor starter of approximately standard construction, and a series of field buttons controlled by a field resistance lever mounted on the same hub post as the starter lever and cooperating therewith.

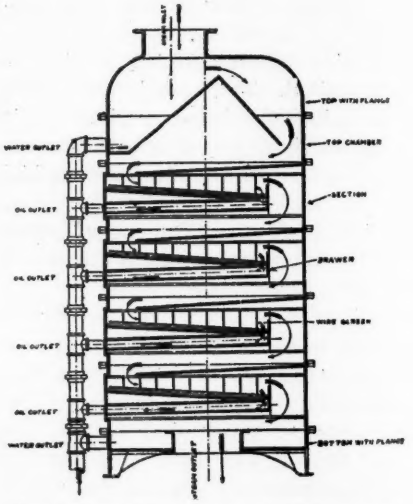
In operation, the motor is started and brought to speed by moving the handle to the right, this handle being attached to the field regulator lever which is mechanically connected to the starter lever so as to move them as one piece in starting the motor. During this operation of starting, the field resistance is short-circuited by an auxiliary contact mounted on the starter lever and a curved sector located just below the armature contacts. When the two levers have been moved to the position in which all resistance is cut out of the armature circuit, a keeper on the starter lever is attracted by the retaining magnet, and the starter lever is held in this position. At this time also the auxiliary contact above referred to has left the curved sector, thus removing the short-circuit from the field resistance. The field lever is now free for movement over the field rheostat buttons at the will of the operator, and may be left at any desired point, thus regulating the speed of the motor as desired. If the retaining magnet is deenergized either by failure of voltage or by operation of overload release devices, the starter lever is released and returns to the starting position, carrying with it the field rheostat lever.

The controllers are arranged with an armature resistance for starting duty only. The field resistance is for two to one speed variation, but three to one and four to one speed variations are furnished if desired. They are made in sizes from one-half to thirty horse-power, and for 110, 220 and 500 volts.

The "Loew" Grease and Oil Separator.

The Loew Supply and Manufacturing Company, Cleveland, Ohio, has completed a line of specialties which is known as the "Loew" grease and oil separator, the "Loew" combination feed-water heater and oil separator, the "Loew" combination closed feed-water heater and oil separator, the "Loew" standard straight-tube heaters, "Loew" steam separators, and "Loew" exhaust heads. The grease and oil separator is shown in the accompanying illustration.

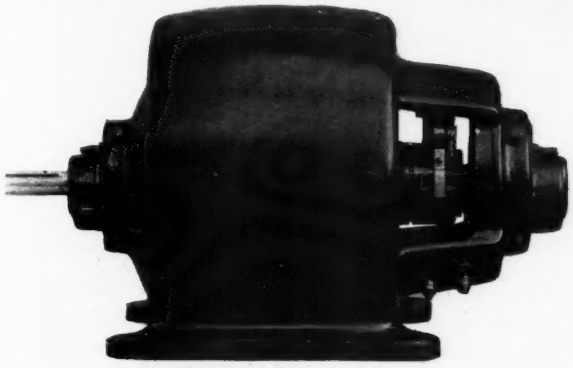
Steam enters at the top and passes downward through the separator, as shown by the arrows. In its passage it is deflected sharply downward several times, striking baffle plates and drawers of fibrous material. The sharp incline of the plate opposite the steam inlet precipitates the first collection of grease and oil to the discharge pipe. The steam then strikes the baffle plates, and then a drawer which is filled with fibrous material and covered with a coarse wire screen, the latter having three small screens placed at right angles, to guide the oil to the fibre underneath. The grease and oil are absorbed by the fibre, and drip through it to the ribbed bottom of the drawer, whence they run rapidly to the outlet pipe. This process is repeated a number of times until the steam finally passes out of the outlet at the bottom. The separator is built in sections, and as many drawers can be added as desired, thus increasing the capacity of the apparatus materially.



THE "LOEW" GREASE AND OIL SEPARATOR.

Westinghouse Bipolar Motors for Direct-Current Circuits.

A line of direct-current motors to be known as the type R has been produced by the Westinghouse Electric and Manufacturing Company to meet the demand for thoroughly reliable and highly efficient machines of small power which shall be easy to install, convenient to operate, require a minimum of attention and give continuous service throughout a long life. They are constructed in sizes from one-sixth to one and three-quarters horsepower and wound for 110 and 220 volts. The fields are shunt-wound. The motors will carry their rated full loads continuously without injurious heating. Commutation is practically sparkless between no-load and an overload of fifty per cent or more and within this range, the brushes, once set, require no readjustment for change of load. In appearance these motors are exceedingly handsome, with graceful outlines and a baked enamel finish which presents a smooth and lustrous surface, pleasing to the eye as well as durable and effective.



WESTINGHOUSE TYPE R MOTOR.

ARMATURE OF WESTINGHOUSE TYPE R MOTOR.

The yoke, brackets and poles are cast in one piece, a construction which gives a compact machine. The bore of the bearing housing supports is the same as that of the field poles. Accordingly, the armature can be removed by simply taking out one bearing housing and this may be done without removing the pinion or pulley, unless it is larger in diameter than the bore of the field poles. The front end bracket is formed by three arms, which afford protection to the commutator, but leave openings through which ready access to the brushes may be obtained. The two poles project inward in a horizontal plane and are magnetized by machine-formed coils. These coils are treated with both a weatherproof and an insulating compound, which ensures them against ordinary dampness as well as accidental grounds or short-circuits. They are covered with a number of thicknesses of tape to guard against mechanical injury. The coil supports are small L-shaped pieces of sheet brass which are fastened to the poles by screws and which hold the coils firmly in place.

The bearings are of the ring self-oiling type, with linings of phosphor-bronze, mounted in separate housings which may be adjusted in any position, so that the oil reservoirs hang vertical whether the motor be set upon the floor or suspended from the wall or ceiling. The housings are so designed as to entirely prevent the leakage of oil. Creeping of oil along the shaft is also prevented by the use of a properly designed oil-thrower or wiper which protects the commutator and armature. The oil reservoirs are of ample capacity and the oil rings are easy to inspect, as they may be seen from the opening in the bearing housing.

These motors are usually furnished without bed-plates, but may be supplied with bed-plates of the universal type, equipped with drip-pans and belt-tighteners and arranged for wall or ceiling suspension as well as for floor mounting.

The armatures are of the slotted drum type with imbedded coils which are retained in the slots by hard fibre wedges, without band wires of any kind. The armature cores are formed of circular punchings of carefully annealed soft steel, treated to secure high magnetic quality and freedom from ageing. Every precaution is taken to keep down the core loss of these machines, and their operating characteristics remain practically constant during life. The armature cores are mounted upon shafts which are so designed that pulleys or pinions may be secured with keys. The leads to the commutator are adequately protected by a covering of treated cloth and tape and are thus tied down and so firmly held in place that there is practically no danger of a broken lead.

The brush-holder arms are mounted upon rings which are supported at three points inside the motor frame. The individual holders are of the sliding type with the rod construction and possess many features of especial merit. Pressure on the brush is exerted by a coiled spring in such a manner as to give the carbon a uniform pressure throughout its width. The carbons are held radial at all times, there being no swivel action during the operation of the machine. A quick acting spring takes up any vibration that might otherwise occur and thus ensures continual contact between brush and commutator and obviates jumping or chattering of the brushes. There are two brushes on each motor, set diametrically opposite each other and easily reached through an opening in the front end bracket.

The commutators are built up of hard-drawn copper bars assembled upon brass bushes. They are made without necks.

The terminals are of the brass bolt and nut construction and are located on the two lower arms of the front end brackets. The bolt or stud is threaded on both ends and is brought through insulated bushings and clamped into position by a nut on either side of the arm. These nuts are properly insulated by Vulcabeston washers. Another nut on either end of the stud serves to fasten the leads. No porcelain or other breakable material is used in the construction of these terminals. They are easily accessible and are largely protected from accidental short-circuit or other injury by their position.

The starting rheostats furnished with these motors are of the most approved design, with automatic no-voltage release. They are exceedingly small and compact and of the best possible construction, and are fireproof throughout. The resistance is of the bar-wound type with porcelain insulation to ground, and is thoroughly ventilated. The adjustment is such that the motor starts without jar or abnormal rush of current.

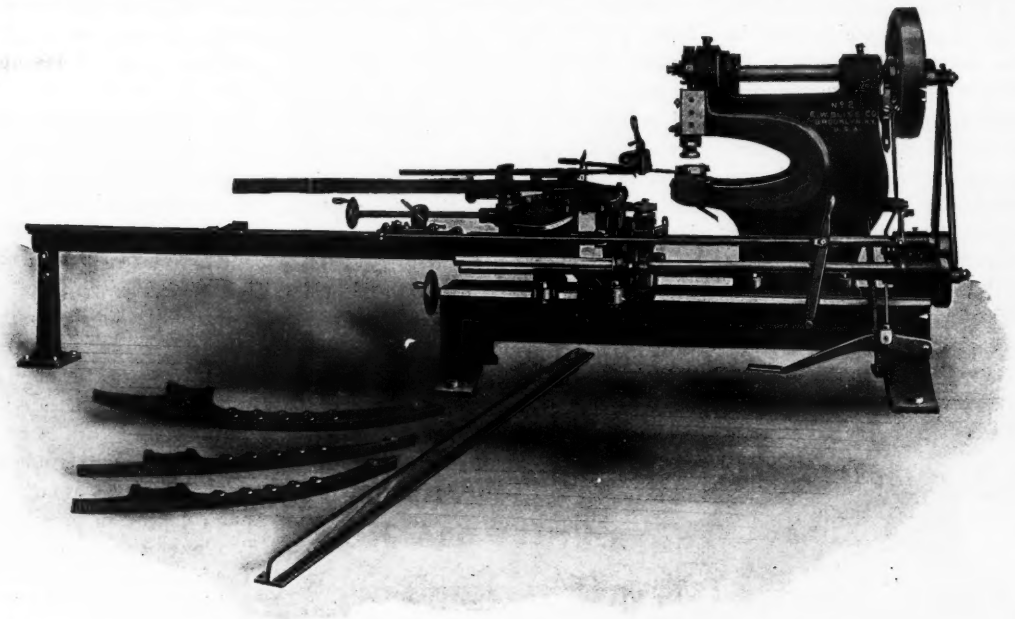
Electric Locomotive Destroyed by Fire.

The large electric locomotive built for the New York Central & Hudson River Railroad Company by the General Electric Company was almost totally destroyed by fire at the substation at Hoffmans Ferry, four miles west of Schenectady, N. Y., on February 19.

A New Armature Disc and Segment-Notching Press.

The accompanying illustration shows the latest type of automatic armature disc and segment-notching press built by the E. W. Bliss Company, 41 Adams street, Brooklyn, N. Y. This machine possesses several unique features which will be of interest to dynamo-electric machine designers. The machine is fitted with a special device for notching the segment. This segment attachment can be rapidly removed and the press arranged for notching plain round discs of any diameter from five to sixty-one inches, and of any number of notches from 12 to 224.

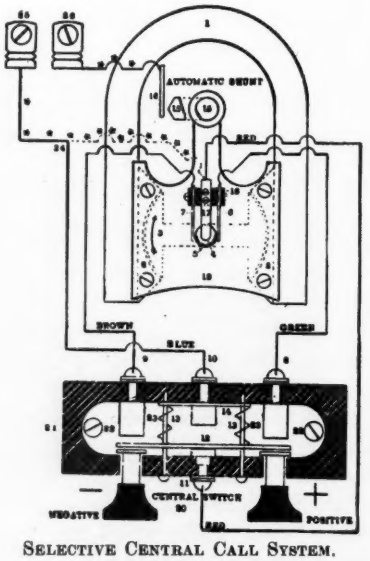
When fitted with the segment-notching device, the machine will notch segments up to those used for the largest generators, and the change from one size of segment to another is easily and quickly made. Each segment, having a different radius, requires a separate sector gear. Several of these sector gears are shown in the illustration, lying upon the floor near the machine. To make a change it is only necessary to remove the two nuts holding the sector gear and place a new one in position. The correct centre for the segment is obtained by moving the table carrying the support for this sector the proper distance from the centre of the slide holding the punch or punches, as the case may be. Provision has been made so that this can be quickly and accurately accomplished. The press will punch one, two, three and even five notches at a time, and will stop automatically when the required number of notches has been cut.



A New Armature Disc and Segment-Notching Press.

The T. & A. Selective Central Call System.

In the accompanying illustration is shown the selective central relay made by the T. & A. Selective Call Company, of Geneseo, Ill. This is a device intended to be used on party lines, and which will enable any station on a party line to call other stations on the same line without calling the central, or to call the central at will. This is accomplished by means of a relay which will respond to a direct current or a unidirectional current, but not to the alternating current given by the usual magneto call generator.



Selective Central Call System.

The relay consists, in the main, of a movable coil suspended by means of flexible wire between permanent magnets. To this coil is attached a forked arm which makes contact with a second rod, which, in turn, releases the drop contact. This relay, resembling, as it does, a D'Arsonval galvanometer, is not deflected when an alternating current is passed through it. It will be deflected, however, by a unidirectional current flowing in one direction. If a unidirectional current is passed in the other direction through the relay it will not operate it, but this may be used to operate a second similar relay placed at a second central. Thus, the relay makes possible the operation of a party line so that any station on the line can call any other station on the same line without calling the central, or any station can call either of two centrals at will. When one station desires to call another on the same line, the usual magneto call is given. This, however, does not throw the drop at either central. If it is desired to call the central, a push-button is firmly pressed, and the generator crank turned. This sends a unidirectional current over the line in the necessary direction to throw the drop at the central with which communication is desired. This, of course, can be made to operate a buzzer, and thus attract attention when so desired.

The relay may be used either in series or bridging. When used in the latter way a retardation coil is connected in circuit, which is very opaque to voice currents and enables the relay to be left permanently in circuit.

The same relay and generator equipment which is used on ground circuit bridged lines is used on straight metallic circuit lines. For old telephones having good generators, but which give only alternating current, a commutator is furnished, which supplies the unidirectional currents necessary for operating the relay.

Small Engine-Driven, Revolving Field Alternators.

The General Electric Company, Schenectady, N. Y., has brought out a line of small engine-driven alternators. This type of alternator is shown in Fig. 1. The machines are furnished either with or without direct-connected exciters.

FIG. 1.—REVOLVING FIELD ALTERNATOR WITH DIRECT-CONNECTED EXCITER.

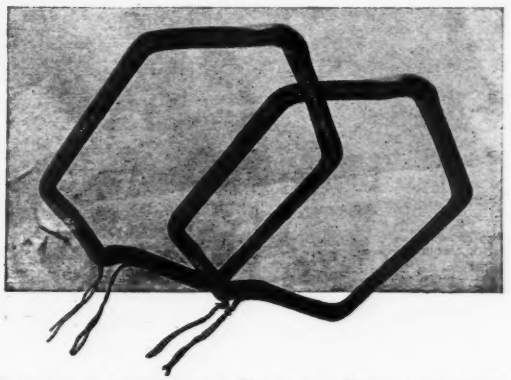


FIG. 2.—ARMATURE COILS OF REVOLVING FIELD ALTERNATOR.

The armature frames are mounted on an extension of the engine subbase. The armature coils are shown in Fig. 2. The teeth of the armature punchings are supported against vibration by steel fingers, and protection is furnished the armature coils by an extended spider frame. The armature may be slid to one side until it clears the revolving field, thus giving good access to both armature and field for inspection or repair.

The revolving field and spider are shown in Fig. 3. The spider is cast in one piece with the rim, and the poles are bolted to the rim. The collector rings are of cast iron, split in two pieces. They are supported by insulated pins on a small cast-iron shell on the shaft.

The armature of the direct-connected exciter used with the machine is mounted on the shaft close to the revolving field. The magnet yoke of the exciter is bolted to the armature frame. In order that it may be easily removed, it is split in two pieces.

On machines with direct-connected exciters the brush-holders for the exciter commutator and generator collector rings are supported by a brush-holder yoke which is part of the exciter. Machines without direct-connected exciters have the brushes for collector rings supported by a yoke which is mounted in a groove in the outboard bearing.

The machines are designed for either two or three-phase work. No change is necessary except in the armature coils and punchings. The exciter and all accessories are the same for both. The machines will carry their full rated capacity at two or three-phase, non-inductive load with a temperature rise not exceeding forty degrees centigrade above that of the surrounding air in any part of the machine. They are designed to carry twenty-five per cent overload for two hours with a temperature rise not exceeding fifty-five per cent above that of the surrounding air.

Machines with three-phase windings will carry seventy-five per cent of their rated polyphase capacity in a single-phase current with the same temperature rise as given for two and three-phase ratings.

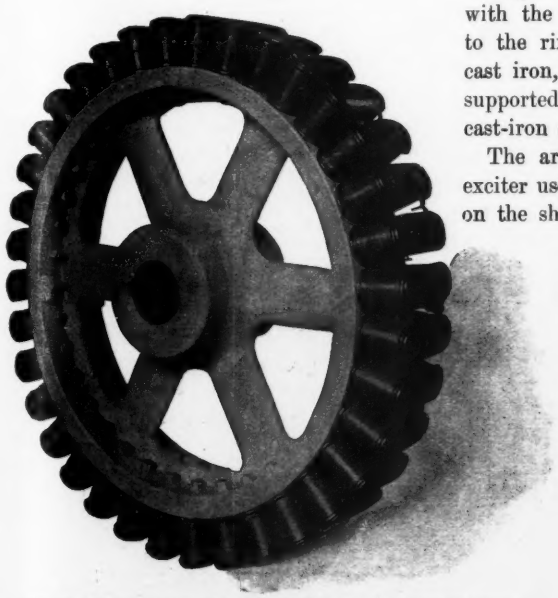


FIG. 3.—REVOLVING FIELD AND SPIDER OF ALTERNATOR.

FIG. 4.—FIELD COILS OF REVOLVING FIELD ALTERNATOR.

Standard designs are for the following potentials: three-phase—240, 480, 600, 1,150 and 2,300 volts; two-phase—240, 480, 1,150 and 2,300 volts.

Air-Compressors at the St. Louis World's Fair.

The Laidlaw-Dunn-Gordon Company, 114 Liberty street, New York city, exhibited at the St. Louis World's Fair two large compressors in Machinery Hall. These compressors furnished all compressed air used at the exposition, and were both sold before the closing day. The larger one goes to shaft No. 3 of the Doe Run Lead Company, at Central, Mo., and the smaller one to the city of Columbia, Mo., for the air-lift water-supply system. The first machine received the only grand prize awarded at the exposition to air-compressors. It has a capacity of 1,300 cubic feet of free air when running at 125 revolutions, and is distinguished by several novel features, the most important of which is the Cincinnati valve gear, the opening and closing of the admission and the closing of the exhaust being controlled mechanically, while the opening of the exhaust is determined by poppet valves, thus permitting high speed without throttling of the air and wear and rattling of the valves. The smaller machine is fitted with mechanically moved inlet valves and is rated at a displacement of 500 cubic feet per minute. Its good workmanship and perfect operation at the exposition so much impressed the officials of the city of Columbia that they countermanded an order on another manufacturer in order to take this compressor.

Steam Turbine Plant in the Klondike.

The Westinghouse companies have entered an order for the equipment of a power-house for the electrical operation of gold-dredging boats on the Alaskan rivers. The plan involves some interesting features. The Canadian Klondike Mining Company, composed of a number of Detroit capitalists, has ordered a 400-kilowatt turbo-generator, to be driven by a 600-horse-power Westinghouse-Parsons steam turbine. The dredge boats are being built by the Marion Steam Shovel Company, Marion, Ohio. On these boats there will be installed induction motors, aggregating a total of about 500 horse-power, and varying in size from seven and one-half horse-power to 100 horse-power.

The power-house will be located at Dawson City, and the dredges will operate on the Yukon river and its tributaries. Lines for transmitting power will be strung from the station to the boats wherever they may be working.

Two Telephone Specialties.

The Yonkers Specialty Company, Yonkers, N. Y., has placed on the market two specialties shown in the accompanying illustrations. Fig. 1 shows the "New York" ground clamp for connecting telephone and telegraph wires to pipes or cables. This clamp consists of a strap of soft tinned copper, in combination with a brass clamping plate and a tightening screw. The screw is provided with a nut and washer to accommodate the ground wire. By means of this device a firm and permanent electrical connection is effected between the ground wire and the pipe. This connection is more secure than a wrapped joint, and the total cost is considerably less.

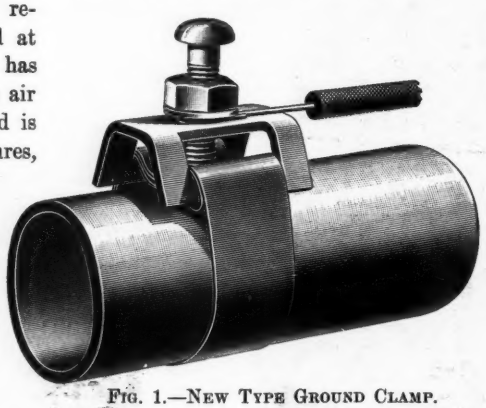


FIG. 1.—NEW TYPE GROUND CLAMP.

Fig. 2 shows the "Metropolitan" cable clip for supporting aerial cables. The steel wire loop is heavily galvanized, and the band which encircles both cable and supporting strand is of zinc. This clip is so designed that, as the strain increases, the clip holds more tenaciously. The clips are designed to withstand a strain of 400 pounds.

FIG. 2.—CABLE CLIP.

In applying this clip, the hooks which engage with the wire loops are bent up tightly, either with the fingers or by means of pliers. The bend of the zinc strap over the supporting strand is made so that the lower loop which encircles the cable is drawn tightly about the cable.

The studs impressed upon the zinc prevent longitudinal displacement.

The standard size of hanger is seven and one-half inches long, and fits twenty-five and fifty-pair cables. Special sizes are made to fit larger cables, as desired.

Extensions to the Carnegie Institute Building at Pittsburg.

The extensions to the Carnegie Institute Building at Pittsburg, Pa., are rapidly nearing completion. They represent an expenditure of $5,000,000, and are the gift of Mr. Andrew Carnegie. The new building almost obscures the original structure, which itself, a previous gift of Mr. Carnegie, cost $3,000,000. Its width on Forbes street is 400 feet and its depth is 600 feet.

In addition to the portion devoted to the library, within the building are to be found art galleries, a museum, a music hall, a lecture room, a restaurant and the general offices required for the supervision and operation of these many divisions. In the basement will be the modeling and casting rooms for the art department, and workshops, where the repairs necessary for the maintenance of the building will be carried out. The printing office and bindery used in connection with the library, and the large lighting and heating plant necessary for illuminating and warming the building are also situated in the basement.

The heating and lighting plant when completed will form a very interesting example of an installation that both in workmanship and appearance will be of very high quality, the specifications on these points being very rigid.

The contract for the electric generators has been let to the National Electric Company, Milwaukee. It consists of five 300-kilowatt, twelve-pole, 125-volt, direct-current, engine-type generators, running at 120 revolutions per minute. All visible bolts will be nickel-plated and the field coils taped on the outside and finished with a wrapping of fish-net cord. The terminal boards will be of Vermont marble. The total net weight of each generator will be about 55,000 pounds, the armature and commutator accounting for 18,000 pounds. On the final test the generators will be expected to withstand a momentary overload of seventy-five per cent without flashing and to operate from no-load to twenty-five per cent overload without shifting the brushes.

The architects, Messrs. Alden & Harlow, have based their designs for the building on the leading institutions of this type, both in Europe and in this country.

The World's Output of Lead.

United States Consul Abraham Smith, at Victoria, B. C., has compiled some statistics showing the annual output of lead for the entire world. For the year 1903 the total amount was 910,000 English tons. For 1902 it was 902,400 tons, and for 1901 it was 875,000 tons. As a producer of lead, the United States leads, the output for 1903 being 266,691 tons. Spain comes next with 172,521 tons, and is followed by Germany, with 141,558 tons. No other country had an output as great as 100,000 tons.

CURRENT ELECTRICAL NEWS

DOMESTIC AND EXPORT.

ELECTRICITY IN COAL MINES—The Colorado Fuel and Iron Company, Denver, Col., has decided to use electric power in the operation of all its coal mines, and it is estimated that nearly $200,000 will be expended for electrical appliances.

A NEW COMMERCIAL CABLE—The Commercial Cable Company is about to begin the construction of a third transatlantic cable. The route that the cable will follow has been determined, and bids for the work have been asked. It is stated that no new stock will be issued on this cable.

LARGE BRITISH POWER PLANT—A company with a capital of £5,000,000 is seeking parliamentary authority to set up electric power stations in London and a part of the county of Essex. There will be, it is expected, 100,000 horse-power in each station at Greenwich, Silverton and Fulham. These will supply power to large and small consumers.

NEW COLORADO POWER PLANT— The Continental Electric Power and Irrigation Company proposes to construct a power and water plant at Empire, Col. A storage capacity of 125,000,000 cubic feet of water, sufficient for the irrigation of 2,500 acres of land, is planned. A large dam will be built, and a power plant installed. Two generators of 600 horse-power will be the initial layout, and it is expected that a maximum of 3,000 horse-power will be obtained.

CINCINNATI TELEPHONE COMPANY INCREASES CAPITAL STOCK—The stockholders of the Cincinnati & Suburban Bell Telephone Company, at an annual meeting held on February 15, voted to increase the capital stock from $4,000,000 to $5,000,000. The following board of directors was chosen: C. H. Kilgour, C. P. Taft, John Kilgour, George Bullock, B. S. Cunningham, W. A. Blanchard, B. L. Kilgour and C. J. French. The directors reelected John Kilgour as president, and B. L. Kilgour as vice-president and general manager.

LIGHTING COMBINE PLANS—A special meeting of the stockholders of the United Electric Light and Power Company was held on February 14, in Baltimore, Md., to act on the consolidation of the Wenstrom Electric Company, of Baltimore city, with the United Electric Light and Power Company. The new company formed by the merger of the Wenstrom company with the United Electric Light and Power Company takes over the majority of the stock of the Consolidated Gas Company. The name of the combined company is the Consolidated Gas, Electric Light and Power Company. The capitalization is $12,700,000.

EXPERIENCE WITH THREE-CENT FARE UNSATISFACTORY IN CLEVELAND—President Horace E. Andrews, of the Cleveland Electric Railway Company, has issued a statement to the city council of Cleveland, Ohio, covering the low street-car fare experiments. Two weeks' trial of the three-cent fare within a two-mile limit showed a loss per day of $764 in the company's earnings. This loss was sustained on only eighteen and one-half per cent of the company's total fares, and for thirteen out of twenty-four hours of the day. At the expiration of the three-cent fare for a two-mile ride, the company put into operation a four-cent, no-limit ride without a transfer, for eight days. The result showed a loss of $1,375 per day, as compared with the company's earnings for the same service for the same number of days prior to the low-fare experiments.

MEXICAN ELECTRICAL NOTES—On February 5, a fire originating beneath the platform of the main switchboard destroyed the greater part of the Mexican Electric Works, Mexico City. The switchboard was a total loss, and three engines and dynamos were badly damaged. The city was in total darkness during the entire night. Arrangements were immediately made to put into operation any of the apparatus which had not been damaged, and to secure extra power from the generating company at San Ildefonso. A company has been organized for the purpose of establishing an electric power plant on the Quebrada river, in the state of Durango, Mexico. The electrical energy to be generated will be used to operate factories in that part of the state. William McKenzie, of Toronto, Canada, and associates have arranged for the purchase of a concession for electric car lines in Monterey, Mexico.

PERSONAL MENTION.

MR. BUFORD ADAMS, manager of the Missouri & Kansas Telephone Company at St. Joseph, Mo., has been appointed field manager of the Wisconsin Telephone Company.

MR. F. E. LEONARD, manager of the Butte office of the Rocky Mountain Bell Telephone Company, has been promoted to take charge of the Salt Lake City, Utah, office.

MR. DUNCAN MACALLISTER has resigned as president and director of the Metropolitan West Side Elevated, Chicago, Ill., his resignation to take effect at the annual meeting on April 4.

MR. H. W. WEBB has been elected president of the Maryland Telephone Company, *vice* David E. Evans, resigned. Mr. Webb has been vice-president and general manager of the company for some time.

PROFESSOR ERNEST RUTHERFORD, of McGill University, Montreal, Canada, has been appointed Silliman lecturer at Yale University for 1905. Previous Silliman lecturers have been Professor J. J. Thomson and Professor C. S. Sherrington.

DR. CHARLES P. STEINMETZ, in an address before the Albany Institute, Albany, N. Y., is quoted as saying that the ultimate results of the successful experiments with electric locomotives will be an electric trolley service between Albany and New York.

MR. S. L. NELSON, formerly general manager of the Fort Wayne & Southwestern Traction Company, has been appointed executive head of the lines constructed and operated by the Appleyard syndicate. A reorganization of this company is to be effected. Mr. Nelson's headquarters will be at Wabash, Ind.

MR. GEORGE H. GALE, of Schenectady, N. Y., one of the many capable young men on the literary staff of the General Electric Company, has succeeded to the duties of Mr. E. H. Mullin, deceased, and will spend half of each week in New York city, in charge of the publicity department of his company.

MR. H. BERGGRAF, a Norwegian engineer, has recently invented a new electrical apparatus for sea-sounding. This is accomplished by an acoustic method. The depths are also registered graphically upon a revolving drum. The operation of the device depends upon the time which sound takes to travel to the bottom and return.

MR. VINTON A. SEARS, Boston, Mass., in a recent letter to the daily press, suggests that the reasonably complete development in the United States of telephone equipments will require over 8,000,000 telephones. This is based upon ten per cent of the population becoming subscribers. This basis is already considered too low for the future by many operating engineers.

MR. ERNEST H. DAVIS, president of the National Electric Light Association, has recently taken an active and conspicuous part in the municipal ownership campaign which has centered around New York city. In a recent statement he protested vigorously against the figures given by the engineering committee which reported to Mayor McClellan on the cost of a city lighting plant. Mr. Davis contends that incandescent lighting service, if supplied from a municipal lighting plant, would not cost less than 12.88 cents per kilowatt-hour, and that private companies now quote twelve cents per kilowatt-hour, and in some buildings six cents. He also says that the cost of $75.40 per year for an arc light should be, according to the figures cited in the report, $97.35, the entire cost, inclusive of subway, real estate and lost taxes, amounting to $140, the present maximum price.

TELEPHONE AND TELEGRAPH.

MIXERSVILLE, IND.—The Brookville Telephone Company is extending its line through Mixersville to Oxford.

SUPERIOR, WIS.—The People's Telephone Company has completed connections through the Consolidated Company, of Minneapolis, with Grand Forks, N. D.

ROSEBURG, ORE.—The Peel & Glide Telephone Company has been organized to build a telephone line to Roseburg. H. L. Engles is president, Frank Livingston, secretary, and Leslie Lily, treasurer.

NEW YORK, N. Y.—The Ocean Steamship Company, plying between New York and Savannah, and Boston and Savannah, and comprising eleven ships in its fleet, has installed wireless telegraphy on all its vessels.

PHILADELPHIA, PA.—The Conestoga Telephone Company, in Berks County, has extended its line to White Bear, Geigertown, Joanna, Morgantown, Churchtown, Bearville and Cedar Lane, connecting with Reading.

JACKSON, MISS.—The Cumberland Telephone and Telegraph Company has purchased the Citizens' Long-Distance Telephone Company, which has a number of lines in the eastern part of Mississippi and the western part of Alabama.

STILLWATER, MINN.—Rural telephone lines connecting with the Northwestern company's exchange in Stillwater have been established, and farmers living near Houlton are about to install a line to connect with the same exchange.

FORT WAYNE, IND.—The Bell Telephone Company has completed the work of equipping the Fort Wayne & Wabash Valley Traction Company's lines between Fort Wayne and Logansport with a complete telephone system, both for despatching trains and for general business.

SCRANTON, PA.—The State Telephone Company has instituted suit against the Interstate Telephone and Telegraph Company for $1,000,000. The declaration alleges that the defendants violated a contract which bound them to construct and operate 500 miles of toll line.

ERIE, PA.—Work has been started on an extension of the Waterford telephone line from West Greene, along the Lake Pleasant road, to Erie. This line will bring a large number of farmers into communication with the outside world, and add to the value of the Waterford exchange.

BALTIMORE, MD.—The contract for 100 telephones used by the United Railways and Electric Company has been awarded by the executive committee to the Maryland Telephone and Telegraph Company. The service will be connected with the largest private branch in the Baltimore telephone service.

FORT WAYNE, IND.—The county commissioners have granted the Home Telephone Company a franchise to erect poles along all of the roads leading from Fort Wayne to the north in Allen County. Franchises were granted on the Goshen road, the Lima, Hicksville, St. Joe, Maysville, Coldwater, Auburn and Winchester roads.

AUSTIN, MINN.—At the annual meeting of the new Tri-State Telephone Company these officers were elected: president, A. O. Dinsmore; vice-president, Thomas Revord; secretary and treasurer, James Keenan; directors, C. A. Sterling and C. H. Webber. A dividend of six per cent in cash and eight per cent in stock was declared, payable April 1.

ALBANY, N. Y.—A certificate has been filed with the secretary of state, announcing that the Madison Mutual Telephone Company, of Solsville, Madison County, has increased the amount of its capital stock from $1,000 to $5,000, divided into shares of ten dollars each. The certificate is signed by A. H. Holland, L. R. Bridge and H. L. Brooks.

ST. JOSEPH, MO.—A deed of trust has been filed in the recorder's office by the Kansas City Long-Distance Telephone Company to the Commonwealth Trust Company, securing that company by a first mortgage. Five per cent gold bonds for $1,500,000 were issued by the Telephone company, and the entire amount was taken by the Trust company.

SAN DIEGO, CAL.—Work on an extension of the telephone line from San Diego to Imperial has been commenced by the Sunset Company. The wires will be strung from San Diego across the mountains and desert, the line being built by way of Julian. The line has already been completed as far as Julian, which is eighty-seven miles from Imperial.

MONTROSE, PA.—At the annual meeting of the stockholders of the Montrose Telephone and Telegraph Company the following officers and directors were elected: directors, J. F. Butterfield, M. S. Dessauer, F. I. Lott, E. C. Rogers and C. L. Stone; officers. J. F. Butterfield, president; C. L. Stone, secretary, treasurer and general manager. The meeting adjourned until March 29, at which time a vote will be taken on the question of increase of capital stock.

OAKS CORNERS, N. Y.—The residents of Oaks Corners have organized a home telephone company. The new company will have connections with the Independent company. Directors have been elected by the new organization as follows: Frank Hood, J. B. Vandervere, Charles Parker, Milton Gerow, Charles Pardee, Stephen A. Smith, Horace Peck. The directors have elected these officers: president, F. A. Hood; vice-president, S. A. Smith; secretary and treasurer, J. B. Vandervere.

ALLENTOWN, PA.—The directors of the Consolidated Telephone Companies, of Pennsylvania, have elected the Hon. R. E. Wright as president; Charles W. Kline, of Hazleton, vice-president; C. M. W. Keck, secretary and treasurer. S. E. Wayland resigned as general manager, and the office was abolished. The duties of the place were put upon a superintendent and assistant superintendent. Charles West, of Wilkesbarre, was elected superintendent, and Charles A Mans, of Hazleton, assistant.

ST. LOUIS, MO.—The annual stockholders' meeting of the Kinloch Telephone Company was held recently, when the old directors were reelected. They are William F. Nolker, Rolla Wells, August Gehner, Philip Stock, Adolphus Busch, C. Marquard Forster, Julius S. Walsh, William D. Orthwein, William J. Lemp, Charles H. Turner, Sam. M. Kennard, Henry Nicolaus and Breckinridge Jones. Most of the stock was voted at the meeting. The company expects to start the erection of its new exchange building at Eleventh and Locust streets within a short time.

NORWICH, N. Y.—The Union Telephone Company has made arrangements with the Central New York Telephone Company, whereby it is connected with the latter company's lines, and for an additional cost of two dollars per year the Union's subscribers may have the use of the Bell system to all points. The Union company now has 100 subscribers in Sidney, and two hundred more in the following near-by villages: Bainbridge, East Guilford, Unadilla, Unadilla Center, Sidney Center, Youngs, Trout Creek, Northfield, Rockdale, Mt. Upton, Rockwell's Mills, Latham's Corners, White Store and Holmesville.

WASHINGTON, GA.—At a meeting of the stockholders and directors of the Wilkes Telephone and Electric Company, J. A. Moses was reelected president for the next fiscal year, with Boyce Ficklen, secretary and treasurer. Reports from the officers of the company showed a gratifying improvement in the business of the past year. New lines have been built in all directions from Washington, reaching every country store in the county, and putting the farmers in closer relation to the county seat than ever before. The company owns about 100 miles of lines, which form a network in the territory tributary to Washington. At the conclusion of business a dividend of forty-three per cent was ordered paid to the stockholders of the company.

NASHVILLE, TENN.—Two bills concerning the telephone business of the state have been prepared. The charges fixed are: in exchanges of over 8,000 subscribers, $4 a month; residence, $2.50; over 3,500, business, $3.50; residence, $2; over 1,000, business, $3; residence $1.75; less than 1,000, business, $2; residence, $1.50. For party lines a reduction of twenty per cent for each additional telephone is required. Long-distance rates shall not exceed one-half cent per mile during the day, and not over half that at night. Discriminations are not allowed, and the companies are required to

permit other companies to connect with their lines. The railroad commission is empowered to adjust rates and charges, correct abuses and suppress extortions.

ERIE, PA.—A new telephone line is being built from Arbuckle to Wattsburg.

LOGAN, UTAH—The Utah Independent Telephone Company is preparing to extend its lines to Logan.

SARATOGA, TEX.—The Southwestern Telephone Company is preparing to install an exchange in Saratoga.

ST. JOHNSVILLE, N. Y.—The Interstate telephone line has been extended from Newville to Cramer's Corners, near Starkville.

ANGOLA, N. Y.—The W. E. Guest Telephone Company, of Evans Center, has purchased a new switchboard and added a number of new telephones.

SUPERIOR, WIS.—The People's Telephone Company has been granted permission to issue bonds to the amount of $100,000. The company's system will be improved.

NASHVILLE, ILL.—The rural telephone line from Nashville to Addieville is announced a certainty by the promoters, and work on the same will be commenced as soon as possible.

MILL CREEK, I. T.—The city council of Mill Creek has granted a twenty-year franchise to the Sulphur Telephone Company. The exchange is expected to be in operation within ninety days.

HELENA, MONT.—The Rocky Mountain Bell Telephone Company will install a common battery system in Helena, and also contemplates the addition of another story to its exchange building.

SALT LAKE CITY, UTAH—A force of Independent Telephone Company employés is erecting telephone poles and stringing wires on the State road, the present destination being Provo. An exchange will probably be established in Lehi.

HAMILTON, OHIO—The Home Telephone Company, of Hamilton, has made an offer for the purchase of the Bell Telephone Company's interests in Hamilton, and negotiations are now pending for the consolidation of the two companies.

HUNTSVILLE, ALA.—Wires for a new system of telephones connecting Huntsville with Jeff, Monrovia, Rep, Kelly and other towns northwest of Huntsville are being put up by private parties. The new system will be connected with the Bell exchange.

INDEPENDENCE, ORE.—Connections with the Polk County rural telephone and Independence have been completed. Independence is now connected with Falls City, Dallas, Perrydale, King's Valley, Lewisville, Corvallis, Airlie and through Yamhill County.

GENESEO, N. Y.—The Livingston County Telephone Company has completed its exchange in Geneseo. The company is connected with over 60,000 subscribers of independent lines in western New York, among them the Home company, of Rochester, and the Frontier company, of Buffalo.

NEW HAVEN, CT.—At the meeting of the stockholders of the Southern New England Telephone Company, the following directors were elected: Morris F. Tyler, Samuel E. Merwin, A. Heaton Robertson, James English, John W. Alling and Max Adler, of New Haven; Thomas Sherwin and Frederick P. Fish, of Boston, Mass.

NEWBURGH, N. Y.—Vincent A. Murray, who is agent for the Hudson River Telephone Company, has made arrangements with the company whereby he leases the mileage, equipment and operating systems of the telephone exchanges of Cold Spring and Garrison, now controlled by the Hudson River Company. Mr. Murray's lease is for five years and takes effect March 1.

BATAVIA, N. Y.—Stockholders of the Stafford Telephone Company held their annual meeting on January 28. The treasurer's report showed the company to be in a satisfactory condition financially. The following directors were elected: Charles J. Call and Howard Bell, three years; Walter Daniels and Jay Lathrop, two years; J. A. North, G. H. Torrey and Dr. Ganiard, one year. At the close of the stockholders' meeting the directors reelected officers as follows: Charles J. Call, president; Dr. Ganiard, secretary; Howard Bell, treasurer.

ALLENTOWN, PA.—At a meeting of the Consolidated Telephone Companies of Pennsylvania the office of general manager, held by C. E. Wayland, of Scranton, was abolished. The duties of that office will hereafter devolve on a superintendent and assistant superintendent, new positions to which Charles West, of Wilkesbarre, and Charles A. Mons, of Hazleton, were elected respectively. These officers were elected: Robert E. Wright, Allentown, president; Senator C. W. Kline, Hazleton, vice-president; C. M. W. Keck, Allentown, secretary and treasurer.

HERKIMER, N. Y.—At a meeting of the stockholders of the County Telephone Company, of Herkimer, the following were elected directors: George W. Fuller and Fred Zoller, of Rochester; W. I. Taber and Robert Earl, Herkimer; James Conkling, of Ilion; T. Harvey Ferris and Charles H. Poole, of Utica. The directors elected these officers: president, Robert Earl; vice-president, James Conkling; secretary, Charles H. Poole; treasurer, W. I. Taber; engineer, Edward Cline. The company has telephones in Ilion, Frankfort, Mohawk and Herkimer.

ELECTRICAL SECURITIES.

The market continued to show the firm undertone that has characterized it since the beginning of the year. Notwithstanding the elimination of the activity of a number of very large interests, due to departures to other financial centres, the changes in price values were not extensive, and at the end of the week values were slightly higher, if anything. Speculative influence is largely dominated by the expectation of a decision in the Northern Securities case. It is highly possible that the verdict which will be handed down by the Supreme Court in a very short time now may send the whole case back to the lower courts. It is hoped, however, that, whatever decision may be reached, it will be final, and will mean an end of this litigation. It is not unlikely that before the court can render its decision a harmonious agreement may be reached between the rival interests. With this matter once settled it is understood that a number of pending railway deals of considerable magnitude will be undertaken. The state of trade in general remains but little improved over the situation for the past month. At a number of recent meetings of sales managers and representatives of territory throughout the entire country the fundamental note has been one of expectancy of large business. There is, however, considerable disappointment in the activity shown so far this year. While it has been quite satisfactory, it has not been what was expected from the extravagant predictions made during the last few months of last year.

ELECTRICAL SECURITIES FOR THE WEEK ENDING FEBRUARY 18.

New York:	*Closing.*
Brooklyn Rapid Transit	62¼
Consolidated Gas	204¼
General Electric	186¾
Interborough Rapid Transit	216
Kings County Electric	200
Manhattan Elevated	173
Metropolitan Street Railway	121⅜
New York & New Jersey Telephone	146
Westinghouse Manufacturing Company	190

At the annual meeting of the New York Edison Company retiring directors were reelected.

Boston:	*Closing.*
American Telephone and Telegraph	142¾
Edison Electric Illuminating	250½
Massachusetts Electric	55¼
New England Telephone	136
Western Telephone and Telegraph preferred	103

The Boston Elevated Railway Company has petitioned the railroad commissioners for authority to issue $7,500,000 bonds to fund floating debt for construction and equipment and the purchase of real or personal property, as may be necessary for the operation of its road.

The instrument output of the American Telephone and Telegraph Company for the month ended January 30 is as follows: gross output, 130,634; returned, 37,700; net output, 92,934, as compared with 53,790 for the same period in 1904. The total number outstanding is 4,573,498.

Philadelphia:	*Closing.*
Electric Company of America	12
Electric Storage Battery common	82½
Electric Storage Battery preferred	82½
Philadelphia Electric	10⅜
Philadelphia Rapid Transit	29⅜
United Gas Improvement	113⅛

Chicago:	*Closing.*
Chicago Telephone	143
Chicago Edison Light	162
Metropolitan Elevated preferred	61
National Carbon common	43½
National Carbon preferred	112½
Union Traction common	13
Union Traction preferred	50

ELECTRIC RAILWAYS.

MADISONVILLE, OHIO—The Cincinnati & Columbus Traction Company has begun work on the roadbed of its proposed route between Madisonville and Madeira.

FREMONT, OHIO—The county commissioners have granted a franchise to the Lake Erie, Bowling Green & Napoleon Railway to construct a line in Woodville township.

CANAJOHARIE, N. Y.—A large number of men in Otsego, Schoharie and Montgomery counties are interested in the construction of an electric road from Milford through Cherry Valley and Sharon Springs to Canajoharie.

PORTLAND, ORE.—The Portland Consolidated Railway Company will build an interurban line between Portland and Hillsboro. Work will commence as soon as the most feasible route can be selected, and the work of construction commenced.

PORTLAND, ORE.—Right of way has been secured for an extension of the Oregon Water Power and Railway Company from Cedarville, two miles west of Gresham, to the Columbia river opposite Washougal, through Fairview and Troutdale.

LEAD, S. D.—It is stated that the Burlington Railway Company will extend the narrow-gauge electric trolley line from Lead to Terry, a distance of about three and one-half miles. This will give passenger service to the mining camps in the Bald Mountain district.

CINCINNATI, OHIO—Incorporation papers for the Cincinnati Northern Traction Company, which is to lease the Cincinnati, Dayton & Toledo, have been forwarded to Columbus. The capital is $500,000, and the incorporators are W. H. McAllister, Nat. S. Keith, D. J. Downey, Dane Stevens and S. C. Cooper.

SEATTLE, WASH.—The Seattle Electric Company has reached an agreement with the government for the building of an electric car line to Fort Lawton. The work will be begun as soon as a franchise can be secured from the city. A question of freight and passenger rates to and from the fort has stood in the way of an agreement being reached for two years.

OCEANSIDE, CAL.—John McCafferty, of Pasadena, a well-known mining man and promoter, is looking into the project of an electric line from San Bernardino to Oceanside. Mr. McCafferty has been going over a projected route which follows substantially the line of the Southern California Railway, except that it enters Fallbrook by a different way in order to avoid the Temecula canyon.

BLOOMDALE, OHIO—A proposition has been made to the Bloomdale town council by the Toledo, Bowling Green & Southern Traction Company for the extension of its line from Jerry City to Bloomdale and on to Fostoria. The company asks the town to sell $200,000 worth of bonds, the proceeds to be used in the construction of the road. The town is also asked to secure certain rights of way.

WILKESBARRE, PA.—The Lehigh Traction Road and the Wilkesbarre & Hazleton Railway Company have passed into the hands of a new management. The new officers are: A. Markle, general manager; C. B. Houck, general superintendent; A. F. Harger, superintendent of transportation. The retiring officers are: general superintendent, George Thompson; assistant superintendent, J. J. McNellis; secretary, E. S. Doud.

BOSTON, MASS.—Another double-track electric road between Boston and Providence is being projected, its promoters being three Boston men, Edwin F. Thayer, Frederick C. Lane and Charles H. Blood. The road will do a passenger and express business, and is designed to run through Hyde Park, Milton, Canton, Sharon, Foxboro, Mansfield, the Attleboros and Seekonk. It is to be known as the Boston & Providence Street Railway.

JOPLIN, MO.—The Spring River Power Company, of Joplin, announces that it will build an electric line from Baxter Springs to Galena, a distance of eight miles. Most of the right of way has been secured, and work of laying the rails will begin at once. The road will be in operation by August. The line will connect at Galena with the Southwest Missouri Electric Railway. The Spring River Power Company has just completed a $500,000 dam at Lowell.

MEMPHIS, TENN.—It is reported that a survey is to be made for an electric line from Nashville to Memphis, the work to be undertaken by Charles F. Henry, of Indianapolis, who is engaged in the construction of a network of trolley lines for the South. Surveys have already been made for lines from Louisville to Nashville and from Nashville to Birmingham. It is said that Atlanta and several other cities in the South are contemplated in the general scheme.

BATH, N. Y.—The construction of the cross-county electric line between Hammondsport and Hornellsville is said to be assured. The route is surveyed and the right of way secured, and arrangements for the incorporation of the company as the Hornellsville & Lake Keuka Electric Railroad are now being made. New York parties will finance the deal. The certificate of incorporation will shortly be filed, after which it is expected work will be commenced upon the road.

RICHMOND, IND.—By the terms of the franchise granted by the county commissioners to the Indianapolis, New Castle & Toledo Traction Company, the company is prohibited from charging more than two cents per mile fare. No fares less than five cents will be accepted, however. The company is granted two years in which it is to have the line built and cars operating in Richmond. The line of the company passes through Wayne, Webster, Clay, Center and Jefferson townships in Wayne County.

ASHEVILLE, N. C.—Within the next thirty days contracts will be let for the first electric freight railway in the South, which is to be built out of Asheville into the mining districts of Madison and Yancey counties, N. C., by the George D. Miles Company. The road will cost $1,000,000. It will be equipped with a $60,000 electric locomotive. The main purpose of the road is to provide an outlet for the mines in the Madison and Yancey districts, in which the company is interested, and which it proposes to develop very extensively.

SPRINGFIELD, OHIO—The Springfield, Troy & Piqua Electric Railway Company, owned by the Bushnell syndicate, has closed a deal by which that road, the Dayton & Troy, the Western Ohio and the Fort Wayne & Lima electric lines will work in harmony with the Clover Leaf, a steam road, on through business to Toledo and St. Louis. Passengers will be handled from Springfield to Troy over the Bushnell line; from Troy to Lima over the Dayton & Troy, and the Western Ohio from Lima to Delphos over the Fort Wayne & Lima, connecting at Delphos for Toledo and the west for St. Louis.

NASHVILLE, TENN.—The Nashville & Columbia and the Nashville & Gallatin electric railways, which recently changed hands at Nashville, Tenn., have been consolidated under the name of the Nashville Interurban Company, with $100,000 capital. The directors are E. B. Stahlman, John A. Pitts, James H. Connor, Joseph Frank, Nat. Baxter, Hilary Howse, John T. Landis, W. J. Whitthorne, of Columbia, and D. K. Spillers, of Gallatin. Mr. Stahlman was president of the Nashville & Columbia and Mr. Baxter was president of the Nashville & Gallatin line. The new company is to take up immediately the work of building the roads.

BANGOR, ME.—According to a bill introduced at Augusta the Bangor, Orono & Old Town Railway, the Bangor, Hampden & Winterport Railway, and the Bangor Street Railway will all be merged into one company; the Old Town Electric Company will be absorbed, and in all probability in the near future the Bodwell Water Power Company will be acquired by the Bangor Railway and Electric Company, which will be the new name for the Public Works Company. It is simply a plan to consolidate properties which are now controlled by the Public Works Company, all excepting the Bodwell Water Power Company, and which will be bonded to the extent of about $1,000,000.

FINDLAY, OHIO—The lease of the Toledo, Bowling Green & Southern Traction Company to the Toledo Urban & Interurban Railway Company for a term of ninety-nine years has been filed in the county recorder's office. The lease is for the entire line of the Toledo, Bowling Green & Southern road from Perrysburg to Findlay, and includes the road and all the property owned, such as lots, franchises, etc., together with the power-house at Findlay. The rental is based on the capital stock of the lessor, which is $1,500,000. The first year the rent shall be one-half of one per cent, or $7,500, and for ten years it shall increase a certain per cent each year until ten years shall have elapsed, when four per cent shall be paid, or $60,000 per year. This sum shall be the yearly rental thereafter during the life of the lease. The Toledo Urban & Interurban company shall also complete the power-house at Findlay at a cost of $200,000.

ELECTRIC LIGHTING.

WESTWOOD, N. J.—Poles have been erected for an electric line from Westwood to River Vale.

ALBION, MICH.—The council has granted a thirty-year franchise to Albion Electric Light Company.

ATWOOD, ONTARIO—W. F. Forrest, of Atwood, will install a plant to furnish electric lights to the village.

LA CROSSE, WIS.—The Wisconsin Light and Power Company has been granted a franchise to operate in La Crosse.

ST. LOUIS, MO.—The St. Louis city council has passed a bill providing for lighting by contract of that part of the city south of Keokuk street.

OGDENSBURG, N. Y.— A movement has been started toward the equipment of electric lighting plants for several hotels and large buildings in and near Ogdensburg.

RUTLAND, VT.—Work on the foundation of the Chittenden Power Company's new plant at Mendon is progressing rapidly. The plant will be ready for operation July 1.

WILLARD, UTAH—At a mass meeting of Willard citizens it was unanimously decided to take steps toward obtaining from Brigham City electricity for light and power.

LIVINGSTON, MONT.—The electric light poles, wires and franchise belonging to A. O. Newton have been sold to T. M. Swindlhurst, of Livingston, representing H. L. Frank, of Butte.

CHICAGO, Ill.—The North American Company has bought the Union Electric Light and Power Company in St. Louis, Mo., and is reported to have about closed a deal for the purchase of the United Railway Company.

PITTSFIELD, MASS.—Announcement has been made that Z. & W. M. Crane have signed contracts for the installation of a large water-power plant at the stone mill in the Renfrew district, to cost between $75,000 and $100,000.

NORWICH, CT.—The Uncas Power Company, of Norwich, has petitioned the Connecticut legislature for incorporation, with the purpose of establishing a water-power plant to generate electricity for sale in Norwich and New London.

STAMFORD, N. Y.—The Walton Electric Light Company is preparing to install a new 175-horse-power Corliss engine. This is made necessary by the increasing demands made upon the company for lights. A new dynamo will also be added.

SANTA BARBARA, CAL.—The merchants of Santa Barbara have organized a new company under the name of the Merchants' Mutual Light and Power Company. This enterprise is the result of the objections and complaints being made against the present system.

PHILADELPHIA, PA.—The Wyoming Valley Electric Company, which has absorbed the companies supplying gas and electricity to Plymouth, Nanticoke, Kingston, Edwardsville, Dorranceton, Luzerne and adjacent townships, has recorded a mortgage for $1,000,000 to secure a bond issue.

LEESBURG, VA.—W. E. Crosen & Company, of Leesburg, have applied to the council of Manassas, Va., for an exclusive franchise for the erection and maintenance in that town of a system of electric lights during a period of fifteen years. The proposed plant will have a capacity of 750 sixteen-candle-power lamps.

PAWTUCKET, R. I.—The directors of the Narragansett Electric Lighting Company have organized for the coming year All of the officers were reelected as follows: Marsden J. Perry, president and general manager; Arthur H. Watson vice-president; Arthur B. Lisle, assistant general manager; E. A. Barrows, secretary and treasurer.

ROME, GA.—At a meeting of the Rome city council a committee was appointed by the mayor to prepare a bill to be presented at the next session of the legislature, authorizing the city to build and operate an electric light plant. The city council has had the matter under consideration for some time. It will cost about $20,000 to build and equip the plant.

LITTLE ROCK, ARK.—J. B. Gray, of England, reports that he has closed a contract with the Martin-Reynolds Electric Company, of Little Rock, by which it will install an electric light plant at England within ninety days. It will be a $5,000 plant, and at first there will be fourteen street arc lights. The plant will be owned and operated by the city.

TEKAMAH, NEB.—At a regular meeting of the Tekamah city council an ordinance was passed providing for the submission to the qualified electors of the city of a proposition to issue bonds in the sum of $10,000 for the purpose of purchasing or installing an electric lighting system and plant, to be owned and operated by the city in connection with the present system of waterworks.

EASTON, PA.—The plant of the Lehigh-Northampton Gas and Electric Company, at Catasaqua, will be overhauled, modernized and enlarged. The improvements will require several months' time. William W. McKee, the receiver, is arranging for the work. Two new engines of 200 and 400-horse-power capacity, a new Stirling boiler, improved condenser, water heater, pumps and switchboard will be installed, and a third wire run through the boroughs of Alliance and Coplay, to afford better service.

NORTHAMPTON, MASS.—At their annual meeting the stockholders of the Northampton Electric Lighting Company elected the following directors: C. H. Pierce, J. T. Stoddard, Frank Lyman, C. E. Gould and George S. Graves, of Florence, the latter being elected to fill the vacancy caused by the death of Samuel B. Fuller. C. H. Pierce was elected president of the board of directors and C. E. Gould secretary and treasurer. About $18,000 was expended in improvements during the past year.

GRAND RAPIDS, MICH.—At the annual meeting of the Vincennes Light and Power Company these directors were chosen: Edward M. Deane, Dwight Smith, Dudley E. Waters, J. Boyd Pantlind, Walter C. Winchester and Claude Hamilton, Grand Rapids; C. A. Peck, Kalamazoo; George E. Berdeen, Oswego; Harry B. Wales, James W. Emerson, Charles E. Bierhaus, Royal E. Purcell, W. H. Vollmer and J. L. Bayard, Jr., Vincennes. The report of the company shows good earnings for the ten months of its existence.

GUTHRIE, OKLA.—The Guthrie Light and Power Company has filed a certificate of an increase of its capital stock from $150,000 to $250,000 which was decided upon at a meeting of the officers and directors on January 10, 1905. The company also filed an amendment of articles of incorporation with the following officers: Thomas H. Smith, of Denver, Col., president and treasurer; Robert Sohlberg, of Guthrie, vice-president; J. R. Cottingham, of Guthrie, secretary. The directors are Thomas H. Smith, of Denver, and U. C. Guss and J. R. Cottingham, of Denver.

MIDDLETOWN, OHIO—A ten-year contract for street lighting has been signed between the Middletown board of public service and the Middletown Electric Light and Power Company. According to the terms of the contract the company agrees to erect a tower, 150 feet high, with four large lamps which are to be lighted every night; to light the city building and the waterworks building free of charge; to erect 113 modern street lights and to light each for $60 per year, a total cost of $6,780 per year. In ten years the city must pay $67,800 for the lighting of its streets. The plant of the lighting company will be ready to commence operations on or before April 10.

GRAND RAPIDS, MICH.—At the annual meeting of the Grand Rapids Edison Company these officers and directors were reelected: Daniel McCool, president; McGeorge Bundy, vice-president; Thomas F. Bechtel, secretary-treasurer, and A. F. Walker, general superintendent. The directors are Daniel McCool, McGeorge Bundy, Thomas F. Bechtel, Harvey J. Holister and George C. Peirce, Grand Rapids; B. T. Becker, F. G. Bigelow and Gordon Bigelow, Milwaukee; H. N. Higinbotham, Chicago; K. K. McLaren, Jersey City, and E. R. Coffin, Schenectady, N. Y. The business for the year 1904 has been most satisfactory to the stockholders, it is stated, showing a considerable increase over the previous year. At the meeting the purchase of additional apparatus to increase the capacity of the several plants was authorized. This apparatus is to be of a type embodying all modern features, and enabling the production of current at a minimum cost. The additions contemplated will involve an expenditure of about $100,000.

NEW INCORPORATIONS.

RICHFIELD, OHIO—West Richfield Telephone Company. $10,000.

TOPEKA, KAN.—Macksville, Prattsburg & Nora Telephone Company. $1,000.

NEW YORK, N. Y.—The Health-Apparatus Company has been formed to manufacture electric healing devices.

CHICAGO, ILL.—Chicago & State Line Railway. $10,000. Incorporator: H. R. McCullough, Lake Forrest, Ill.

CHICAGO, ILL.—Wadeford Electric Company. $2,500. Incorporators: J. W. Castle, George Lackie, F. S. McClory.

ASHLAND, ORE.—Jacksonville Electric Company. $10,000. Incorporators: C. R. Ray, A. E. Reames and Peter Diesch.

NEW YORK, N. Y.—Kerr Electric Company. $1,000. Directors: D. A. MacIntyre, O. B. Goldsmith, A. L. Davis, New York city.

LITTLE ROCK, ARK.—Waldron Telephone Company. $2,000. Incorporators: C. E. Forrester, J. E. Frisby and J. O. Johnson.

MARINGOUIN, LA.—Plaquemine Electric Light and Power Company. $30,000. Directors: J. H. Savage, M. Dick and V. M. Barber.

WASHINGTON, D. C.—Empire Light and Power Company. $500,000. Incorporators: D. S. Fletcher, N. A. Smith and K. M. Fletcher.

HARRISBURG, PA.—Rohrerstown, Landisville & Mount Joy Street Railway Company. $60,000. President, Charles B. Keller, of Lancaster.

MAINE, N. Y.—Nonticok Valley Telephone and Telegraph Company. $1,000. Incorporators: William Clark, W. E. Dyer and D. Dudley, Maine.

EAST ST. LOUIS, ILL.—Ozark Mountain Electric Railway Company. $5,000. Incorporators: John Nimes, F. W. Hackman, Jr., and E. W. Hartman.

DULUTH, MINN.—Duluth Electric and Construction Company. $50,000. Incorporators: Charles A. Hutchinson, Harold E. Pierce and Van S. McKenny.

UTICA, N. Y.—Franklin Springs Electric Light Company. $5,000. Incorporators: F. DeW. Smyth, D. DeW. Smyth, Utica, N. Y.; Ed B. Stanley, Clinton, N. Y.

METUCHEN, N. J.—Metuchen Gas and Electric Light Company. $50,000. Directors: A. F. Rittenmeyer, Patrick Convery, Robert Carson and L. D. Johnson.

LUFKIN, TEX.—Lufkin Electric Light and Power Company. $30,000. Incorporators: S. W. Henderson, G. F. Hackney and J. S. Henderson, all of Lufkin.

PALMYRA, N. Y.—Palmyra Gas and Electric Company. $25,000. Incorporators: C. C. M. Hunt, C. McLouth, Palmyra, N. Y.; G. S. Sheppard, Penn Yan, N. Y.

HARTFORD, CT.—Sterling Manufacturing Company. To manufacture electricity. $50,000. Incorporators: L. B. Penfield, F. W. Baker and M. J. Hogan.

ALBANY, N. Y.—College Hill Electric Light Company. $5,000. Incorporators: Charles B. Rogers, Utica, N. Y.; Joseph Riedd, Samuel J. Saunders, Clinton, N. Y.

BUFFALO, N. Y.—Iroquois Electric Company. To manufacture electricity. $1,000,000. Incorporators: Edmund Hayes, W. H. Hotchkiss and G. K. Birge, Buffalo.

AURORA, ILL.—Fox River Light, Heat and Power Company. Changed to Western United Gas and Electric Company, and capital increased from $500,000 to $6,500,000.

TRENTON, N. J.—Madison River Power Company. $6,000,000. Incorporators: Pressley E. Risland, Allen J. Nichols, William S. Brayton, Charles R. Gauter and Albert S. Ridley.

EDWARDSVILLE, ILL.—Jerseyville Illuminating Company. $1,000. Incorporators: Owen Ford, of St. Louis; J. N. C. Shumway, of Taylorville, and H. A. Shepherd, of Jerseyville.

CLARKSVILLE, TENN.—The Clarksville Electric Street Railway Company. Changed to Clarksville Railway and Light Company, and capital increased from $20,000 to $250,000.

CANTON, OHIO—Sandy Valley Light, Heat and Power Company. $25,000. Incorporators: William L. Davis, Grant B. Wells, John L. Allman, Charles Frey and Harrison B. Webber.

PARIS, ILL.—Paris Traction Company. $5,000. Incorporators: Andrew J. Hunter, F. L. Kidder, Charles P. Hitch and Hugar L. Hodges, of Paris, Ill., and John J. Cummings, of Chicago, Ill.

TRENTON, N. J.—The Alaska Fuel, Power and Transportation Company. $1,000,000. Incorporators: W. H. Duval, of Allenhurst, N. J., and J. Warren Dickson and A. C. Shentone, of New York.

ST. CLOUD, MINN.—Commercial Telephone Company, of Belgrade, Minn. $50,000. President, T. J. Anderson; vice-president, Chris Borgerding; secretary, J. F. Chisholm; treasurer, Alexander Ridgeway.

CHICAGO, ILL.—Chicago Edison Light Company; $2,500; incorporators: Clayton R. Taylor, Percy B. Eckhart and Thomas G. Deering. Edison Electric Illuminating Company; $2,500; same incorporators.

PORTLAND, ORE.—Portland, Sandy & Mount Hood Electric Railway. $10,000. Incorporators: Seneca Smith, Portland; Napoleon Davis, Eastern Multnomah; George L. Story, Guy G. Willis and A. S. Done.

JACKSON, MISS.—Durant-Lexington Electric Railway Company. Organized to build an interurban line between the towns of Lexington and Durant. $200,000. Incorporators: Chester Jones, Truman Jones and W. O. Glines.

ZANESVILLE, OHIO—Zanesville, Cambridge & Northern Traction Company. $10,000. President, Frank McCormac, of New Concord; Samuel Nicholson, of Coshocton, secretary, and H. A. Sharpe, of Zanesville, treasurer.

PORTLAND, ME.—The Chapman Electric Neutralizer Company has been incorporated with a capital of $500,000, of which $500 is paid in. The officers are: president, F. C. Payson; treasurer, R. C. Payson, both of Portland.

RALEIGH, N. C.—The Andrews Light and Power Company, of Andrews. To construct and maintain waterworks, electric light and power plants, telephone plants, etc. $100,000. Incorporators: J. Q. Barker, E. G. Henneman and others, Andrews.

AKRON, OHIO—Wadsworth & Western Traction Company. To build an electric line from Barberton to Wadsworth. $10,000. Incorporators: Byron W. Clendening, George H. Heffner, William A. Ault, Charles S. Johnson, Samuel Cunningham and H. S. Davidson.

MOLINE, ILL.—Rock Island, Moline & Davenport Railway Company. $5,000. Incorporators: C. G. Hipwell, E. J. Daugherty, E. S. Ausderheide and J. W. Walsh, of Davenport, and John W. Greene, Stuart Spaulding, C. E. Soule, Jr., and William A. Rawson, of Chicago.

NEW YORK, N. Y.—The Connecticut Dynamo and Motor Company has been incorporated with a capital of $17,000 to manufacture electrical appliances. The incorporators and directors for the first year are D. McDonald, H. J. Brewer and J. P. Munn, all of New York city.

SPRINGFIELD, ILL.—East St. Louis, Waterloo & Chester Suburban Railway Company. To construct a road from East St. Louis to Waterloo and Chester. $25,000. Incorporators: Thomas M. Chase and Tyron J. Woodward, of St. Louis, Mo.; James P. Slade and A. P. Garrett, of East St. Louis, and Edward F. Schonening, of Columbia, Ill.

EAST ST. LOUIS, ILL.—St. Louis, Freeburg & Fayetteville Railroad Company. To build a road from Belleville to Fayetteville, both in St. Clair County, Ill. $10,000. Incorporators and first board of directors: E. A. Ambs, of O'Fallon, Ill.; George Geisler and A. Vogler, of St. Louis, Mo., and Adolph A. Wolf and Peter Yaeger, of Freeburg, Ill.

SPRINGFIELD, ILL.—Central Illinois Interurban Railroad Company. To construct a road from Peoria to Pekin, Mason City, Springfield, Havana and Lincoln. $5,000. Incorporators and first

board of directors: John B. Abbott, Paul A. Enlows, Fritz Hindahl, Claude L. Stone and Otto S. King, all of Mason City.

SPRINGFIELD, ILL.—Red Budd Light and Power Company. $20,000. Incorporators: J. A. Hamilton, A. B. Daab and L. D. Turner, Jr.

NEW YORK, N. Y.—Rose Telephone Company. $15,000. Incorporators: H. K. Rose, M. J. Rose, South Kortright, N. Y.; C. E. Hanford, Hobart, N. Y.

LINCOLN, NEB.—Sidney Electric Service Company, of Sidney; to establish a power plant for commercial purposes. $10,000. Incorporators: M. C. Callahan and C. Callahan.

YOUNGSTOWN, OHIO—The Cleveland, Youngstown & Ohio River Railroad Company. $200,000. Incorporators: Thomas E. Connell, Frederick B. Hamilton, James J. McNally.

ALBANY, N. Y.—Brooklyn Telegraph and Messenger Company; to maintain a telegraph, telephone and messenger service in Brooklyn. $100,000. Directors: M. N. MacDonald, A. E. Grinnell, E. W. Hunt, L. MacDonald, Albert T. Leonard and A. F. Kelley, of Brooklyn, and M. G. Clum, of Yonkers.

WAUKEGAN, ILL.—Watseka & Kankakee Traction Railway Company; to be constructed from Watseka, Iroquois County, to Kankakee, Kankakee County, Ill. $25,000. Incorporators and first board are David Magill, George W. Hoyt, Walter H. Hogan, O. F. Morgan and Robert L. Harrell, all of Watseka, Ill.

NEW COMPANIES.

HARRISBURG, PA.—The Hulton Electrical Company, of Scranton, has been organized with a capital of $20,000.

AUGUSTA, ME.—The International Electric Appliance Company, of Augusta, has been incorporated to manufacture electrical appliances. The capital is $50,000. I. L. Fairbanks, of Augusta, is president and treasurer.

PHILLIPSBURG, N. J.—The Electrical Specialty Manufacturing Company has been incorporated by Clarence Walters, F. K. Moyer and W. H. Walters, with a capital of $60,000. The company will do a general electrical business.

BOSTON, MASS.—The Charles N. Wood Electric Company has been incorporated with a capital of $50,000. Charles N. Wood is president, Walter E. Geer is treasurer and Nathan L. Wood is clerk. The directors are the above named.

DERBY, CT.—The Automatic Electric Time Switch Company has been organized to manufacture a device by which electric lights may be automatically switched on or off at any desired hour. The company has elected these officers: president, E. M. Rogers, of New Haven; vice-president, A. W. Piper, of Derby; secretary, C. E. Hoyt; treasurer, Charles L. Hoyt.

ENGINEERING SOCIETIES.

PENNSYLVANIA STATE COLLEGE BRANCH, AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS—On Wednesday evening, February 15, the Pennsylvania State College branch of the American Institute of Electrical Engineers discussed the paper on modern central station design, by J. E. Moultrop.

SOCIETE BELGE D'ELECTRICIENS—The January issue of the monthly bulletin of the Société Belge d'Electriciens contains several interesting papers. M. H. Haller and H. Hoern describe some recent hoisting machines. M. J. Carlier describes methods and apparatus for measuring time, distances, speed and acceleration. The headquarters of the society are at 42 rue d'Isabelle, Brussels.

OBITUARY NOTICES.

MR. ALBON MAN, one of the pioneers in the development of the incandescent lamp, died at the Hotel St. George, Brooklyn, on Saturday, February 18. He was seventy-eight years of age. Mr. Man was a practising lawyer, with offices in the Morris Building, 68 Broad street, New York city. He was a graduate of Union College.

MR. WILLIAM K. ACKERMAN, formerly president of the Illinois Central Railroad, died at his home in Chicago, Ill., on Tuesday morning, February 7, in his seventy-third year. Mr. Ackerman was born in New York city January 23, 1832. In 1891 Mr. Ackerman was selected as auditor for the World's Columbian Exposition. During the mayoralty of John P. Hopkins he was city comptroller of Chicago. He was the author of several publications relating to railroads, among them being "Early Railways of Illinois," and "Notes on Railway Management." He was also a frequent contributor to magazines and newspapers. Mr. Ackerman was a member of the Chicago Club.

MR. EUGENE F. PHILLIPS, the founder of the American Electrical Works, died of heart failure on the morning of Wednesday, February 22, at his home in Providence. Mr. Phillips was one of the best known manufacturers of insulated wire and copper wire in the United States, and was a pioneer in this field. His company has grown from a small beginning, until it is one of the largest, Mr. Phillips commencing business in his own name in 1870, and in 1882 organizing the American Electrical Works. The company has a large branch factory in Montreal, and agencies in many of the large cities. Mr. Phillips's two sons, Frank N. Phillips and E. Rowland Phillips, were active in the management of the American Electrical Works, the former having been president for several years. Mr. Phillips was very widely known, was a gentleman of commanding character and highly popular throughout the entire electrical field. He inaugurated the famous Rhode Island clambakes for the electrical fraternity, and for many years invited his electrical friends to meet him annually and enjoy a bake at some one of the famous Rhode Island clubs at Providence. His death will be very widely and deeply mourned. He leaves a widow, two sons and one daughter.

LEGAL NOTE.

COMMON BATTERY AUTOMATIC SIGNAL BOARD DECISION—In the circuit court of the United States for the Northern District of Illinois, Southern Division, in the suit in equity of the Western Electric Company, complainants, *vs.* the Galesburg Union Telephone Company and Howard Knowles, defendants, Judge Seaman handed down an opinion dismissing the bill for want of equity. The bill was for alleged infringement of letters-patent No. 669,708, issued March 12, 1901 (on application filed February 28, 1895), to Charles E. Scribner, for apparatus for telephone switchboards.

INDUSTRIAL ITEMS.

THE REYNOLDS DULL FLASHER COMPANY, Chicago, Ill., through Egbert Reynolds Dull, announces that on February 14 a suit in equity was instituted in the United States Circuit Court for the Northern District of Illinois, by Egbert Reynolds Dull, against the Reynolds Electric Flasher Manufacturing Company, Chicago, and Christian F. Ziegler, for alleged infringement of Sinclair patent No. 566,874, and Dull patent No. 780,641, praying an injunction and award of damages. The Sinclair patent covers broadly the combination of a cam, a knife switch and a reducing gear in train. The Dull patent covers the combination of a knife switch, a carbon auxiliary and a gravity drop in flashing devices.

THE NATIONAL ELECTRIC COMPANY, Milwaukee, Wis., announces that Mr. Walter Fairchild has been placed in charge of the New York office at 135 Broadway. Mr. Fairchild formerly represented the Bullock Electric Manufacturing Company in this city, and prior to that was the New York representative of the Stanley Electric Manufacturing Company. Mr. Robert S. Hopkins has been appointed New York city sales agent, with headquarters at 135 Broadway. Mr. J. Frank Perry has been appointed sales engineer of the National Electric Company. His field of operation has been largely through New England, but he has been connected with large power installations in all parts of the world. Mr. Perry is at the present time in California, representing the interests of the National Electric Company.

THE AMERICAN VITRIFIED CONDUIT COMPANY, New York city, is distributing a rather striking booklet, which it has named "Pointers." It contains a table for making preliminary estimates of the cost of laying conduits, and describes the various

types of conduits which it manufactures. A partial list of the users of the conduits made by this company is also given.

THE LECLANCHE BATTERY COMPANY, 111-117 East One Hundred and Thirty-first street, New York city, will be pleased to send its new circular, descriptive of the "Gonda" wedge cell.

W. GREEN & COMPANY, 6 Maiden lane, New York city, are issuing a circular calling attention to their "Imperial Solderene," which they say is a preparation which will take the place of soft solder and acids in electrical, dental and jeweler's work.

THE BROWN & SHARPE MANUFACTURING COMPANY, Providence, R. I., is mailing its general catalogue for 1905. The volume has been thoroughly revised, and contains considerable new matter. A number of tables are given, and these, together with other general information, make it a valuable book of reference.

THE KRYPTOL GESELLSCHAFT, LIMITED, 56 Unter den Linden, Berlin, N. W., is distributing a price-list of hot plates, combustion furnaces, drying ovens, etc., which are heated by Kryptol, which is a new resistance material for heating by electricity. This substance was described in the ELECTRICAL REVIEW of October 29, 1904.

THE DOUBLEDAY-HILL ELECTRIC COMPANY, 919 Liberty street, Pittsburg, Pa., is distributing its net price catalogue of field coils, armatures coils, armatures, switchboards, etc. These catalogues are being distributed to the electrical trade from Pennsylvania to the Gulf of Mexico. Any company which has been missed in the distribution should apply at once to the company.

THE F. H. STEWART ELECTRIC COMPANY, 275 North Seventh street, Philadelphia, Pa., now occupies the whole building—four floors and basement—at this address. In addition to this large building the company has a large warehouse. The F. H. Stewart company is carrying a very much increased stock, these facilities being necessary because of a rapidly increasing business.

THE HARVARD ELECTRIC COMPANY, 60 West Van Buren street, Chicago, Ill., is distributing several illustrated catalogues and price lists. The company is the manufacturer of fuses, cut-outs, distributing boards, terminals, heat coils, cable hangers, magnet winders, connectors, paper sleeves and other electrical specialties. This material is listed in these catalogues, which will be sent upon request.

THE L. B. ALLEN COMPANY, INCORPORATED, 1335 Columbia avenue, Chicago, Ill., is calling attention to its soldering compounds and specialties in a unique manner, mailing a heavy tag to its patrons which bears on the reverse side nine statements addressed to the electrical field. The card calls attention to the Allen soldering stick, soldering salts, fluxes, commutator lubricant, metal polish and self-fluxing solder.

THE ROBBINS & MYERS COMPANY, Springfield, Ohio, has issued a comprehensive price list of its standard motors and generators. This price list is of side-pocket size, and contains complete lists of the various types of motors regularly furnished for various applications, in sizes from one-sixteenth to fifteen horse-power, and dynamos from one-half to ten kilowatts. Copies of this price list may be obtained by communicating with the company.

THE D. T. WILLIAMS VALVE COMPANY, Cincinnati, Ohio, was incorporated several weeks since. It is now very busy installing the new machinery. A portion of this equipment was secured in Cincinnati and the remainder was purchased in the East. This machinery is all of the latest and most approved design. The building that it is remodeling is 100 by 191 feet, and will accommodate 100 men. The company will manufacture a full line of valves, lubricators, oil and grease cups, etc.

THE LORD ADVERTISING AGENCY, Scranton, Pa., has issued the first edition of "Lord's List of Trade Papers." This list has been prepared for the convenience of present and prospective trade paper advertisers. The endeavor has been made to list only those papers which are of advertising value to manufacturers of machinery, appliances and materials used in technical industries. The book contains a selected list of trade papers in the lines mentioned, and will, no doubt, prove a valuable compendium on classified trade paper advertising.

THE EDISON ELECTRIC ILLUMINATING COMPANY, Brooklyn, N. Y., under the title "Five Thousand Dollar Bills," has published a very interesting pamphlet, showing typical instances to the use of incandescent lamps in and around the borough or Brooklyn, and calling attention to a few subscribers to the Edison lighting and power service whose bills for current are annually upward of $5,000, and whose aggregate consumption is in excess of $325,000 a year. A number of fine half-tones, showing night views of various scenes, are added to the book. There are also illustrations of interior effects, which are instructive and interesting.

THE H. W. JOHNS-MANVILLE COMPANY, 100 William street, New York city, will be pleased to send, upon request, a small pamphlet entitled "Pipe and Boiler Coverings and Their Uses." This pamphlet describes various forms of abestos and magnesia sectional pipe covering, and tells of their use and value for both steam and hot-water pipes, and for protecting pipes from freezing. Prices of coverings, elbows, tees and valves are listed. The annual meeting of the H. W. Johns-Manville Company was held in the company's office, New York city, on January 16. The following officers were elected: J. G. Cannon, chairman of the board of directors; T. F. Manville, president; C. B. Manville, vice-president; Charles Hathaway, vice-president; C. W. Gladwin, vice-president and treasurer; H. E. Manville, secretary. The directors are the officers and H. W. Johns, William H. Porter and C. R. Manville.

THE WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY, Pittsburg, Pa., has closed a contract for electrically equipping the large cotton mill of the Dwight Manufacturing Company, of Chicopee, Mass. The equipment is upward of 130,000 spindles, comprising both ring spindles and mule spindles and about 3,500 looms, and is at the present time driven by water and steam, the water power being supplied from the Chicopee river, on which the mill is located. It is intended to operate a portion of the mill continuously by motors and other parts are to be operated by electric drive in case of low water. The present contract provides for the following apparatus to be delivered and erected by the Westinghouse company; one 440-volt alternating-current generator, 900-kilowatt rated capacity, to supply three-phase current at a frequency of sixty cycles. This generator is to be direct-connected to a C. & G. Cooper 26 and 52-inch by 48-inch stroke cross-compound condensing engine; one twenty-five-kilowatt exciter direct-connected to Westinghouse engine; one twenty-two and one-half-kilowatt motor-driven exciter. There will also be provided a four-panel switchboard to control generator, exciters and six feeders. The electric power plant is to be placed in a new building, to be built as an addition to one of the present engine houses The following Westinghouse type C motors wound for sixty cycles, three-phase, will be located in the various parts of the mill: two 200 horse-power, 580 revolutions per minute; six 100 horse-power, 580 revolutions per minute; three 75 horse-power, 690 revolutions per minute; three 50 horse-power, 850 revolutions per minute; two 40 horse-power, 850 revolutions per minute. The complete equipment of the new plant is from the plans of Messrs. Lockwood, Greene & Company, of Boston. The Westinghouse company has also closed a contract with the United Railways and Electric Company, of Baltimore, Md., for an alternating-current generator to be rated at 5,000 kilowatts. It will be of the flywheel type, with tnirty-two poles, and will run at ninety-four revolutions per minute. The generator will be wound for 13,000 volts, three-phase, with a frequency of twenty-five cycles. The 5,000-kilowatt generator now on order is to have the same characteristics and to run in parallel with the five 2,000-kilowatt generators which the Westinghouse company has installed in the Pratt street station in Baltimore. The company has sold to the La Belle Iron Works, at Steubenville, Ohio, a direct-current engine-type generator, to be rated at 1,000 kilowatts, the voltage to be 250. The contract includes also a switchboard of blue Vermont marble. The Westinghouse apparatus already installed in this plant includes alternating and direct-current generators with a total rated capacity of 1,250 kilowatts, a 300-kilowatt rotary converter and over 200 motors, not including those used on the cranes, ranging in size from 1 to 300 horse-power. About two-thirds of these are Westinghouse type C alternating-current motors.